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Essays in Growth and Development

by

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Abstract

This thesis contributes to economic growth and long-run economic development literature which continues to be the most exciting, challenging and admissible sub-areas of economics. Growth and development is multi-faceted as it is not just concerned with the growth at aggregate levels but it also includes the elemental changeover of the economy, for instance, social, institutional, sectoral and structural transformations. This leads to the rich cluster of questions and various new econometric methods and approaches to find their answers. Some of these questions such as sources of growth pattern differences among countries, the factors responsible for the differences in progress of a nation and the impact of financial development and remittances on economic growth are the subjects of present work. The suitable modeling techniques are adopted to recognize the sources and causes, and also to explain the underlying factors and variables responsible for such growth variations and differences across countries.

This dissertation comprises of three chapters addressing three different aspects related to growth and development of the countries. In second chapter, the sources of growth are determined around growth regime changes using DEA- Malmquist Productivity Index technique combined with the derived structural breaks in growth series. The variant of unified Fit and Filter methodology is applied, which allows to detect large number of breaks in growth series which get excluded in case of filter based methods or statistical techniques. This approach helps to determine the structural breaks in the growth series firstly, by identifying true breaks in the volatile growth series, generally related to developing countries and secondly, by detecting the false breaks in relatively smooth growth series, usually associated with developed countries. Moreover, the productivity growth is decomposed into efficiency change, technological progress, capital deepening and human capital accumulation using DEA-Based Malmquist Productivity Index approach. The results suggest importance of efficiency changes for both positive and negative

structural breaks in growth series. Besides, they also highlight the positive role of factor accumulation on growth accelerations.

A two-stage (DEA and regression) analysis of the determinants of Nation's progress is conducted in the third chapter. Nation's progress of a country is an essential element in growth theory, and its measurement is not exclusively based on economic factors but also on social, environmental and human welfare variables. The aim of this study is to examine the influence of the potential economic, institutional, demographic and geographic determinants on the progress of a nation. The performance of a nation is measured as an estimated efficiency score within which it transforms a given number of endowments such as human and physical capital into national well-being and general human welfare. The economic, environmental and human well-being yardsticks, namely GDP per capita, persons employed, carbon dioxide emission and availability of clean water with proper sanitation facilities are used to measure the nation's progress. The estimated bias adjusted performance scores in stage 1 are regressed on the potential covariates. Simar and Wilson's double bootstrap procedure is used, which allows valid inferences in the presence of an unknown serial correlation in the efficiency scores. The second stage results reveal that the considered covariates play a significant role in the progress of a nation.

In fourth chapter, a panel of 103 countries including developed and developing economies over the period 1980-2014 is used to study the role of financial development, remittances and their interaction terms on economic growth and total productivity. The results suggest positive role of financial development (FD) and remittances (REM) on economic growth. Moreover, the interaction terms (FD.REM) support the substitution hypothesis, which suggest the relaxing role of remittances in case of weak financial markets in receiving countries. However, the role of financial development and remittances on productivity growth is insignificant. Furthermore, the state of development of the countries also influences

the corresponding roles of remittances, financial development and their interaction terms on economic growth.

Zusammenfassung

Die vorliegende Arbeit leistet einen Beitrag zur empirischen Wachstumsliteratur und damit auch zum Themengebiet der langfristigen Wirtschaftsentwicklung. Dieses Gebiet der Volkswirtschaftslehre stellt nach wie vor das spannendste, aber auch herausforderndste Teilgebiet dar. Wachstum und Entwicklung sind vielschichtige Phänomene, so dass nicht nur Größen auf aggregierten Ebenen berücksichtigt werden dürfen, sondern auch elementare Veränderungen der Wirtschaft, wie die sozialen, institutionellen sektor-spezifischen und strukturellen Eigenschaften beachtet werden müssen. Dies wirft ein breites Spektrum an Fragen auf, zu deren Beantwortung verschiedene und neue ökonometrische Methoden und Ansätze benötigt werden. Einige dieser Fragen, die mit der vorliegenden Arbeit beantwortet werden sollen, lauten: ,,Welche Faktoren liegen den zu beobachtbaren Unterschieden in den Wachstumsmustern einzelner Länder zugrunde? Welche Faktoren sind für die Unterschiede im Fortschritt einer Nation verantwortlich? Wie wirken sich die finanziale Entwicklung und die Rücküberweisungen auf das Wirtschaftswachstum aus? Geeignete Modellierungsverfahren wurden adaptiert und angewandt, um einerseits die Ursachen von Wachstumsunterschieden zu ermitteln, und um andererseits die zugrundeliegenden Faktoren und Variablen für solche Wachstumsvariationen und deren Unterschiede zwischen einzelnen Ländern zu erklären.

Die vorliegende Arbeit besteht aus insgesamt vier Kapiteln, in denen unterschiedliche Aspekte im Zusammenhang mit Wachstum und Entwicklung von Ländern behandelt werden.

Im zweiten Kapitel werden die Ursachen für Wachstum in Bezug auf Veränderungen im Wachstumsmuster untersucht. Als Grundlage hierzu dienen der DEA-Malmquist Produktivitäts-Index sowie hergeleitete Strukturbrüche in den Wachstumsraten. Eine Variante der Fit-und-Filter-Methode wird herangezogen, die es erlaubt, häufig vorkommende Strukturbrüche in der Datenreihe der Wachstumsraten aufzudecken,

welche beim Einsatz von filterbasierenden oder statistischen Methoden nicht ermittelt werden können. Dieser Ansatz findet Strukturbrüche einerseits dadurch, dass er die Identifikation von realen Unterbrechungen in den unstetigen Wachstumsraten, wie sie häufig bei Entwicklungsländern auftreten, ermöglicht, und andererseits scheinbare Strukturbrüchen in relativ stetigen Wachstumsraten, wie sie üblicherweise bei Industriestaaten vorliegen, feststellt. Darüber hinaus wird die Produktivitätssteigerung unter den Gesichtspunkten der Effizienzänderung, des technologischen Fortschritts, der Kapitalintensivierung sowie der Akkumulation von Humankapital mit Hilfe des DEA-Based-Malmquist Produktivitätsindex - Ansatzes zerlegt. Die Ergebnisse weisen auf die Bedeutung von Effizienzänderungen für positive und negative strukturelle Brüche in Wachstumsreihen hin. Außerdem betonen sie die positive Rolle der Faktorakkumulation bei Wachstumsbeschleunigungen.

In Kapitel drei wird eine zwei-Stufen-Analyse (DEA und Regression) über die Determinanten des Fortschritts eines landes durchgeführt. Der Fortschritt eines landes ist ein wesentliches Element der Wachstumstheorie. Seine Messung basiert nicht nur ausschließlich auf wirtschaftlichen Faktoren, sondern wird auch durch soziale, ökologische Variabeln als auch durch das menschliche Wohlergehen beeinflusst. Ziel der Studie ist es, den Einfluss potentieller wirtschaftlicher, institutioneller, demographischer und geografischer Determinanten auf den Fortschritt einer Nation zu untersuchen. Die Leistung eines landes wird als geschätzter Effizienzwert gemessen, bei dem eine Reihe von Faktoren, wie menschliches und physisches Kapital, in nationales Wohlbefinden und allgemein menschliches Wohlergehen umgewandelt werden. Die wirtschaftlichen, ökologischen und menschlichen Wohlfahrtsmaßstäbe, nämlich das Pro-Kopf-BIP, die Beschäftigungszahlen, die Kohlendioxidemissionen und die Verfügbarkeit von sauberem Wasser mit geeigneten sanitären Einrichtungen werden zur Messung des Fortschritts eines landes verwendet. Die geschätzten Werte für die Bias Adjusted Performance in Stufe 1 sind auf die potentiellen Kovariaten zurückgebildet. Hierzu wird das von Simar und

Wilsons entwickelte doppelte Bootstrap Verfahren eingesetzt, da es trotz Anwesenheit von unbekannten seriellen Korrelationen in den Effizienzwerten gültige Schlüsse zu ziehen erlaubt. Die Ergebnisse der zweiten Phase zeigen, dass die betrachteten Kovarianten eine bedeutende Rolle für den Fortschritt einer Nation spielen.

Im vierten Kapitel werden Daten aus 103 Industrie- und Entwicklungsländern im Zeitraum von 1980-2014 dazu herangezogen, um die Rolle der finanziellen Entwicklung, der Remissen und ihrer Interaktionsbedingungen für das Wirtschaftswachstum und die Gesamtproduktivität zu untersuchen. Die Ergebnisse deuten auf eine positive Rolle der finanziellen Entwicklung (FD) und der Remissen (REM) auf das Wirtschaftswachstum hin. Darüber hinaus unterstützen die Interaktionsterme (FD.REM) die Substitutionshypothese, welche auf eine entspannende Rolle von Geldüberweisungen im Falle schwacher Finanzmärkte in den Aufnahmeländern hindeutet. Die Rolle der finanziellen Entwicklung und der Remissen für das Produktivitätswachstum ist jedoch unbedeutend. Darüber hinaus beeinflusst der Entwicklungsstand der Länder auch die entsprechenden Rollen von überweisungen, finanzieller Entwicklung und deren Interaktionsbedingungen auf das Wirtschaftswachstum.

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Dedicated to my parents . . .

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Abbreviations

BP	**B**ai and **P**erron
CRS	**C**onstant **R**eturns to **S**cale
DEA	**D**ata **E**nvelopment **A**nalysis
DEAP	**D**ata **E**nvelopment **A**nalysis **P**rogram
DMU	**D**ecision **M**aking **U**nit
DGP	**D**ata **G**enerating **P**rocess
FDI	**F**oreign **D**irect **I**nvestment
FF	**F**it and **F**ilter
GDP	**G**ross **D**omestic **P**roduct
GMM	**G**eneralised **M**ethod of **M**oments
GTFP	**G**rowth of **T**otal **F**actor **P**roductivity
HACC	**H**uman **C**apital **A**ccumulation
ICRG	**I**nternational **C**ountry **R**isk **Guide**
KACC	**C**apital **D**eepening
KR	**K**umar and **R**ussel
OECD	**O**rganization for **E**conomic **C**o-operation and **D**evelopment
PWT	**P**enn **W**orld **T**able
R & D	**R**esearch and **D**evelopment
TFP	**T**otal **F**actor **P**roductivity

UNCTAD	**U**nited **N**ations **C**onference on **T**rade and **D**evelopment
VRS	**V**ariable **R**eturns to **S**cale
WDI	**W**orld **D**evelopment **I**ndex

Symbols

Chapter 1

$D_o(x, y)$	Output Distance Function
e_t	Efficiency score at time t
emp	Number of persons engaged
h	Trimming factor (minimum number of observations per segment)
H	Human capital
hc	Index of human capital per person
K	Capital
k	ratio of capital stock per labor
L	Labor
$\hat{L}$	Amount of labor input measured in efficiency units
M_o^t	Malmquist (output oriented) Productivity Index at time t
$\mu_{i\tau}$	Activity level
pop	Population
$rkna$	Capital stock
$rgdpna$	Real GDP
$rgdpo$	Output side Real GDP
τ_t	Technology set at time t

Y	Aggregate output
y	Ratio of output per labor
$\hat{y}$	Growth of productivity

Chapter 2

B	Set of bootstrap estimates at Step 3
β	Vector of parameters to be estimated
ϵ_i	Continuous iid random variable
γ	Non negative intensity variable
Γ	Set of bootstrap estimates at step 6
$\mu(x, y)$	Efficiency scores
$\hat{\mu}_i$	Efficiency estimates
$\hat{\hat{\mu}}_i$	Bias corrected efficiency estimates
φ	Production set
x	Vector of N inputs
y	Vector of M outputs
z	Vector of covariates

Chapter 3

$CGOV$	Ratio of claims on central government to GDP
DM_2	Volatility of M_2
$DREM$	Volatility of remittances
e_{it}	Observation specific error term

FD	Financial development
INF	Inflation
M_2	Ratio of broad money supply to GDP
$PRVT$	Ratio of domestic credit to private sector to GDP
REM	Remittances
W	Set of control variables
X	Set of explanatory variables
YPC	GDP per capita

Chapter 1

Introduction

Economic growth and long-run economic development literature continues to be the most exciting, challenging and admissible sub-areas of economics. Growth and development is multi-faceted as it is not just concerned with the growth at aggregate levels but it includes the elemental change-over of the economy such as the social, institutional, environmental, sect-oral and structural transformations. There is a long history of economic growth and development analysis of countries and regions and also the distribution of outcomes of economic activity among population and the factors affecting economic growth. This leads to the rich cluster of questions and various new econometric methods and approaches to find out their answers. In general, measurement of the economic performance of a country is becoming fundamental for economic growth and development analysis and also for the policy making, whereby, the assessment of growth and development is done mostly in terms of GDP.

This thesis consists of three separate papers which empirically investigate three different aspects related to economic growth and progress of the countries. The non-parametric growth accounting techniques are employed in this work to determine the changes in total productivity and its sources, that is, technical efficiency

and technological changes, and efficiency scores. Data envelopment analysis (DEA) is a linear programming technique, developed by Charnes et al. (1978) [61], used to estimate production function. DEA is extensively used to determine technical efficiency in a range of industries [63]. The key advantage of non- parametric accounting technique, DEA, is that it accommodates multiple inputs and multiple outputs more easily. Moreover, there is no need to impose a specific functional form of production function in a model.

In the second chapter, research efforts are focused on the decomposition of productivity changes into its components (efficiency and technological changes, capital deepening and human capital accumulation) around the structural breaks in growth series. Since Data Envelopment Analysis explicitly allows for the possibility of non-efficient production, catch up growth due to the efficiency improvements and growth due to the innovations can be distinguished [123]. Färe et al.(1994) [80], based on the Malmquist productivity index (MPI) [57], showed how to account for the productivity changes over time. Kumar and Russel (KR) (2002) [134], under the assumption of constant returns to scale, decomposed changes in income per worker into efficiency change, technological change and capital accumulation components. Such decomposition promote the understanding of determinants of a better performance and provide the private and public sector managers and planners with the valuable information. Within a two stage DEA in the third chapter, a bootstrap method as described by Simar and Wilson (2007)[202], to achieve bias corrected efficiency estimates and to approximate the asymptotic distribution, is employed. For a two stage procedure the Data Generating Procedure (DGP) in the second stage presented by them is logically consistent with regressing non-parametric DEA efficiency scores on covariates that are different from the inputs used to measure the performance in the first stage. Furthermore, MPI methodology is employed in the fourth chapter to obtain growth of total productivity to determine the impact of financial development and remittances on productivity growth.

In second chapter of this dissertation DEA- Malmquist Productivity index technique is used to decompose total productivity into its components around growth series transitions (positive or negative breaks). The empirical literature is growing in this field to shed light on the existence of the structural breaks and furthermore, on the reasons for the major shifts in growth series. In this work a relatively new and better technique Fit and Filter as suggested by Kar et al. (2013) [121], which joins statistical and filter methodology to estimate structural breaks in growth series, is employed. Unlike cross country growth analysis the main focus of the current study is on the turning points in growth performance of the countries. It pays attention to the shifts in the growth paths and the mystery of growth transition within a country and highlights the fact that average growth rates can mask very distinct growth paths. Moreover, this work also deals with changes in productivity as a main source of growth regime changes. The non-parametric growth accounting technique is used to decompose the productivity changes into efficiency changes, technological progress, capital deepening and human capital accumulation. After identification of the structural breaks in growth series for 180 countries the relative importance of productivity changes and factors accumulation are discussed as proximate causes for the observed shifts. The results suggest the importance of efficiency changes for both positive and negative structural breaks in growth series. Besides, they also highlight the positive role of factor accumulation in growth accelerations.

A two-stage (DEA and regression) analysis of the determinants of Nation's progress is conducted in the third chapter. Nation's progress is an essential element in growth theory and it measures the performance of a country which is not exclusively based on economic factors but also on social, environmental and human welfare variables. The aim of this study is to examine the influence of the potential economic, institutional, demographic and geographic determinants on the progress of a nation. The performance of a nation is measured as an estimated efficiency score within which it transforms a given number of endowments such as human and physical capital into national well-being and general human welfare.

The approach to access growth and progress by using only GDP per capita, is often strongly criticized as it does not measure the inequalities in terms of different dimensions of well-being among nations[65]. Moreover, GDP is only the proxy or partial measure of multi-dimensional population well-being theme, which simultaneously includes both economic and non-economic aspects of the societies. The economic, environmental and human well-being yardsticks, namely GDP per capita, persons employed, carbon dioxide emission and availability of clean water with proper sanitation facilities are used to measure the nation's progress. The estimated bias adjusted performance scores in stage 1 are regressed on the potential covariates. Simar and Wilson's double bootstrap procedure is used, which allows valid inferences in the presence of an unknown serial correlation in the efficiency scores. The second stage results reveal that the considered covariates play a significant role in the progress of a nation.

In the fourth chapter a panel of 103 countries including developed and developing economies over the period 1980-2014 is used to study the role of financial development, remittances and their interaction terms on economic growth and total productivity. Panel econometric technique, ordinary least square (OLS) is used. Moreover, to address the issue of endogeneity, for instance, the plausible impact of higher economic growth and productivity on remittances and financial development, leading to overstatement of effects, instrumental variable estimation techniques (IV-2SLS and IV-GMM) are employed. The results suggest the positive role of financial development (FD) and remittances (REM) on economic growth. Furthermore, the interaction terms (FD.REM) support the substitution hypothesis, which suggest the relaxing role of remittances in case of weak financial markets in the receiving countries. However, the role of financial development and remittances on productivity growth is found to be insignificant. Besides, the state of development of the countries also influences the corresponding roles of remittances, financial development and their interaction terms on economic growth.

Chapter 2

Structural Breaks in Growth Series and Decomposition of Productivity Changes

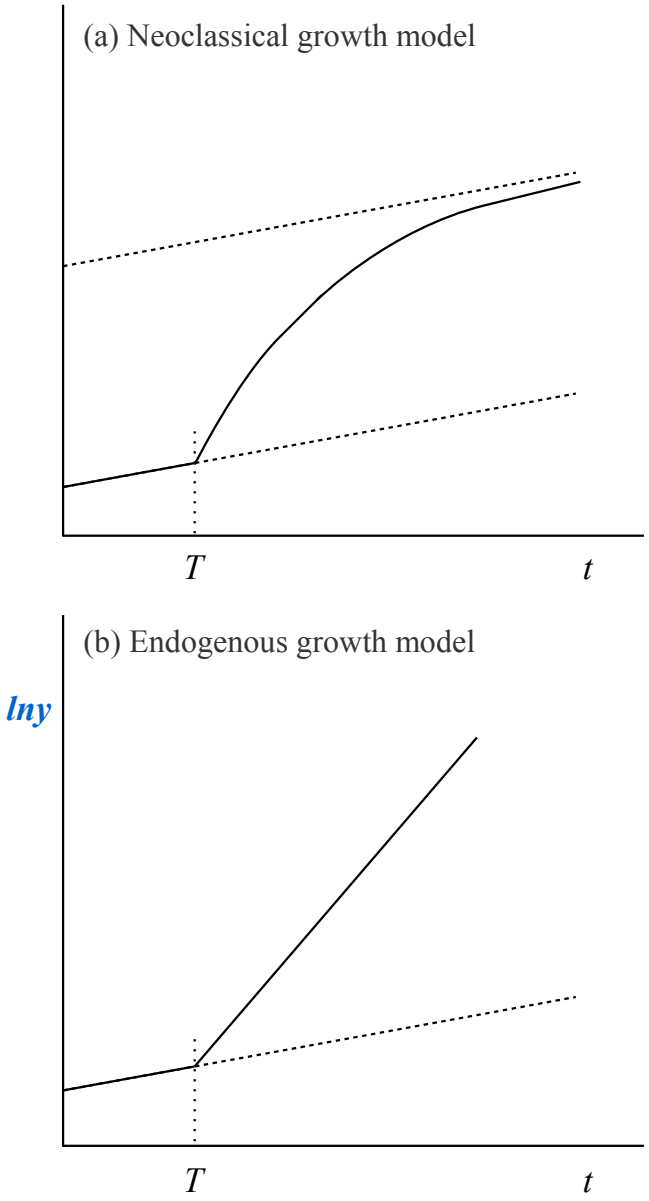
A non-parametric growth accounting technique is combined with the derived structural breaks in growth series to determine the sources of growth around growth regime changes. The transitions in growth series are determined by using the variant of unified Fit and Filter methodology, which helps to avoid the weaknesses of filter based approaches and statistical techniques applied to determine the structural breaks in the related existing literature. Afterwards, the productivity growth is decomposed into its components attributable to efficiency change, technological change, capital deepening and human capital accumulation around the structural breaks in growth series. The deterministic methods, requiring no functional form specification for technology or any assumption about market structure or absence of the market imperfections, are used to construct production frontier. The results suggest the importance of efficiency changes for both positive and negative structural breaks in growth series. Besides, they also highlight the positive role of factor accumulation on growth accelerations.

2.1 Introduction

The process of economic growth can be better understood by combining the transitions (up or down breaks) in growth series and the factors causing these transitions. This suggests the analysis of such growth regimes and transition dynamics. A lot of interesting variations get averaged when growth data is lumped together without considering the turning points in a growth series. However, a significant mileage can be obtained by identifying the transitions in a growth experience and by looking at the sources of these structural breaks. Growth accelerations and deceleration have been largely the mystery as the "usual aspects" explain only a small fraction of what is going on during transition [44]. Moreover, the standard growth theory also emphasizes to look for the shifts in the growth trend to uncover and reveal the relationship between growth and its fundamentals. In both neoclassical and endogenous growth models, as shown in fig 2.1 the best approach to identify the relevant growth fundamentals is to look for the changes happening at or before time T, where the growth accelerates [105].

Since early 1990's, cross country growth regressions are widely used to explain the differences in the long term growth among the countries. Economists used various econometric approaches to shed light on the faster growth of some countries than others. Early work by Barro and Sala-i-Martin (1992) [35] used cross section econometrics in which the growth rates for two to three decades is regressed on the country characteristics and policies. Hall and Jones (1999) [101], and Acemoglu et al.(2001) [1] focused on level regressions with income as a dependent variable rather than growth. Islam (1995) [114], and Caselli et al.(1996) [55] used panel econometric and organized the country level data into the averages over five years or other intervals. However, all these works ignored the fundamental characteristic "lack of persistence" of growth of the developing countries. Growth performance tends to be highly unstable as first mentioned by Easterly et al.(2001) [76]. Only a few countries experienced high and persistent growth rates over the period of several decades. Pritchett (2000) [175] emphasized that if developing country output paths look more like mountains, cliffs and plains than the steady hills observed

FIGURE 2.1: Effect of Growth Fundamentals Improvement at the Time T. [105]



in the industrial world, then looking for an explanation of average cross-country growth differences can lead to the misleading results. Therefore, the inspiring approach can be the exploitation of hidden information in the turning points of growth performance of the countries [44].

There exist highly unstable growth rates over time, virtually in all the countries [75, 175]. Moreover, it is hard to explain the persistent differences in living standards across countries in the world [144]. A voluminous literature on economic growth, both theoretical and empirical, attempted to explain these differences exists. For instance, economic theorists such as Solow (1956) [206], Romer (1986,1990) [187, 189], Lucas (1988) [144], Aghion and Howitt (1992) [11], Barro and Sala-i-Martin (1997) [36] and Mankiw et al.(1992) [146] discussed them as the consequence of steady state growth rate dissimilarities across countries. Whereas, on the empirical side the steady state concept is applied to explain the differences in long run average growth rates of the countries. However, in preceding literature it is being realized that this, lumping of the long run growth rates, fails to capture very important "stylised fact" of economic growth. Moreover, although the growth pattern of developed economies is well described by the single long run average growth rate but this is not true for most of the developing countries exhibiting multiple structural breaks in growth series [121].

External or internal shocks and policy changes can bring sharp shifts in the growth process thus pushing a country from one growth regime to the other. However, such shifts may not be accompanied by significant growth fundamentals, like institutions, education, development of financial institutions, geography, etc. At any point in time, the growth performance and average long run growth rate of the country depends upon the regime it is in, how it switches between regimes and how much time it spends in each regime [115]. This highlights the immense potential of studying the growth patterns within a country and also suggests to develop deeper understanding of the impact of determinants like policies and institutions

on the long run economic growth.

Instead of restricting the analysis to differences in the long run average growth rates, the empirical literature is growing to shed light on the existence of the structural breaks and furthermore, on the reasons for the major shifts in growth series. Two early precursors to this research area are Pritchett (2000) [175], and Ben David & Papell (1998) [40] who employed the statistical techniques to identify the shifts in growth performance. Jerzmanowski (2006, 2011) [115, 116] estimated a Markov- switching model that distinguishes four distinct growth regimes and by using a multinomial logit model found that institutional quality and policies help to determine transition probabilities among these "growth states".

A few relevant research papers, motivated by Pritchett (2000) [175] and the analogous work by Aguiar and Gopinath (2007) [12], Ben David and Papell (1998) [40], and Easterly et al.(1993) [75], attempting to reveal the informational aspects of growth regime transitions and their determinants – are Berg et al.(2012) [44], Reddy and Minoui (2009) [180], Deana and Gamba (2008) [69], Jones and Olken (2005, 2008) [117, 118], Paap et al.(2003) [167], Hausmann et al.(2005, 2006) [105, 106], Jerzmanowski (2006, 2011) [115, 116], Pattillo et al.(2005) [170], Rodrik (1999) [183], Aizenman and Spiegel (2010) [13], Arbache and Page (2010) [23], Becker and Mauro (2006) [39], Dovern and Nunnenkamp (2007) [72], Jong A-Pin and De Haan (2007) [119] and Monika Kerekes (2011) [123].

Berg et al.(2012) [44] employed the duration analysis on the data of 140 countries to look directly at the duration of growth spells. Rodrick (1999) [183] used regression techniques on cross country growth regimes and presented the growth spells to unleash the reasons of structural changes. Sahay and Goyal (2007) [93]used the correlation analysis to highlight the factors that are different across the growth spells (good and bad). Discrete choice models are used to find the events after which a growth spell occurred. Although, there are evidences that the changes in

terms of trade, policies, economic reforms, trade liberalization play some role in the growth transitions but the actual reasons remain largely a mystery.

In accordance with the neoclassical growth models [37, 206], the growth literature widely accepts the importance of total factor productivity changes in the long run growth [56, 76, 101, 174]. In neoclassical growth models, the regime dynamics are caused by changes in the capital stock. Galor and Moav (2004) [89] and Porter (2011) [173] stressed on the role of capital accumulation at the initial phase of the industrialization. Although, changes in total factor productivity contribute in the growth regime changes, there is a surprising role of productivity changes in the short run [123]. Jones and Olken (2005) [117] investigated the approximate causes of transitions between high and low growth episodes using parametric growth accounting. They found the relative importance of productivity changes in growth accelerations and deceleration, whereas, the role of factor accumulation is found to be small for both types of the growth transitions.

Unlike cross country growth analysis, the main focus of the current study is on the turning points in growth performance of the countries. It pays attention to the shifts in the growth paths and the mystery of growth transition within a country and highlights the fact that average growth rates can mask very distinct growth paths. Moreover, this work also deals with changes in productivity as a main source of growth regime changes. The derived structural breaks in the growth series are used along-with non-parametric growth accounting technique to decompose the productivity changes into efficiency changes, technological progress, capital deepening and human capital accumulation. After identification of the breaks in the growth series for 180 countries, the relative importance of productivity changes and factors accumulation as proximate causes for the observed shifts are discussed. In this work the non-parametric growth accounting is used, under the mild assumptions of free disposal and constant returns to scale, which enables to

decompose total productivity growth into changes in production efficiency, technological progress, capital deepening and human capital accumulation.

This chapter adds to the the existing pertinent literature in number of ways. Firstly, the structural breaks are determined by employing a variant of a new unified approach "Fit and Filter" (FF) suggested by Kar et al.(2013) [121]. The approach involves two steps, where in the first step the Bai and Perron methodology [28–30] is used to select the plausible breaks from the data and in the second step a filter is applied to the candidate breaks from the first stage. The breaks are estimated by using *strucchange package* in R statistical software. This FF approach helps to remove the weak points of both statistical and filter approach as it is more broad based and provides an identification mechanism to capture a larger number of true breaks. Secondly, data coverage is increased by using the Penn World Table 9.0. Thirdly, each growth episode is required to last for eight years to make sure that the growth spells are not mixed with the business cycles during analysis of the sources of growth regime transitions. A total of 546 genuine breaks are obtained by applying the FF technique out of which more than 65% pertain to the upper middle, lower middle and lower income countries thus identifying the structural breaks even in the case of volatile growth series. Fourthly, the sources of regime transitions are estimated at structural breaks, by using the identified large number of true breaks. DEA Malmquist productivity index technique is employed. The role of efficiency change is found to be important in productivity growth regime changes.

The remaining chapter is organized as follows. The section 2.2 describes the methodology used to calculate the structural breaks in the growth series and the theoretical framework of non-parametric growth accounting. Section 2.3 discusses the data. The results and discussion are presented in the section 2.4. The last section 2.5 concludes.

2.2 Methodology

The breaks in growth regimes are identified using the variant of the Fit and Filter technique [121]. The non-parametric growth accounting technique is used to obtain the components of productivity growth. In the following subsections both of the methodologies are discussed.

2.2.1 Identification of Structural Breaks

The key to understand economic growth lies with the explanation of the transitions in growth series, rather than explaining the long run growth averages. This requires the knowledge of breaks timing in the growth series. For the determination of the structural breaks, important questions to be considered are the following:

- How to detect the persistent enough breaks in the growth series to highlight the growth pattern of a country?
- How to make sure that the breaks are not due to the variance increase of growth series over time?

Easterly et al.(1993) [75] identified that for most of the countries there is a lack of persistence in medium term growth rates indicating the transitional (high and low) growth regimes. Ben David and Papell (1998) [40] showed that most of the developed and developing countries go through the growth transitions rather than growing at a steady state. Pritchett (2000) [175] presented that fitting a single average growth rate over a long period gives very poor statistical results for a large number of countries, in particular the developing nations. Inspired by the findings of Pritchett (2000) and related work, a set of recent studies attempted to identify the breaks in GDP per capita growth series of the countries.

In the relevant literature two distinct approaches, developed to measure the structural breaks, are used. The first approach identifies the growth breaks based on the subjective rules and known as "Filter based approach". Hausmann et al.(2005, 2006) [105, 106] used this approach to study the breaks that involve growth accelerations and growth collapses, respectively. Aizenman and Spiegel (2010) [13] studied takeoffs- periods of stagnation followed by periods of sustained high growth. The second approach uses the statistical structural break tests to identify the breaks and statistically significant changes in growth series by using the estimation and testing procedures. In this approach the methodology designed by Bai and Perron (BP) [28, 29] is used to locate and test the multiple structural breaks within a time-series framework. In BP methodology, firstly, an algorithm searches all the possible sets of breaks and determines for each number of breaks (upto a maximum number of breaks) the set that produces the maximum goodness of fit. Secondly, the statistical tests determine whether the improved fit allowed by an additional break is sufficiently large, given what may be expected by chance [118]. The sequential testing of k versus $k+1$ breaks, starting with null or no breaks, helps to determine the suitable number of breaks.

Jones and Olken (2008) [118] used the Bai- Perron model on small samples, by implementing the Monte Carlo experiment. The growth process spanning 40 years was modeled allowing for auto-correlation and structural mean shifts of different sizes. They found that the Bai- Perron model is "conservative in detecting breaks and captures only major accelerations and breaks". Berg et al.(2012) [44] used the variant of the model proposed by Bai and Perron by extending the algorithm for sequential testing of structural breaks, described in detail by Antoshin et al.(2008) [22]. Their approach differs from the Bai-Perron approach as it uses sample specific critical values, which takes into account the heteroskedasticity and sample size as compared to the asymptotic critical values, thus improving the power and size of the test. Kerekes (2011) [123] used the BP model to compute the structural breaks in growth series with non-parametric growth accounting to find the impact of total productivity changes and its components on economic growth. Deana

and Gamba (2008) [69] applied the Bai- Perron model to detect the breaks in the growth series of 183 countries using the PWT version 6.1 and then regressed both the negative and positive breaks on three kinds of explanatory variables: external shocks, institutions and policies.

However, Kar et al.(2013) [121] argued that both the filter-based and statistical approaches have serious shortcomings. The filter-based approach lacks consistency in the identification of breaks due to ad-hoc nature of the predetermined filters by the researcher. Whereas, the Bai and Perron test is limited by the low power leading to the rejection of true breaks suggested by the behavior of underlying GDP per capita series. In addition, these two approaches when identifying the current break, fail to take into account the previous growth breaks in same growth series of a country. They proposed a unified framework, also used in this research work, which they called Fit and Filter approach. It involves the best fit of BP method to the data to select the candidate breaks and then applies the filter on them to identify the genuine breaks.

A variant of the Fit and Filter approach [121] is used in the current work to identify the structural breaks in growth series. This helps not only to remove the short comings of filter based and statistical approaches, as discussed earlier, but also allows to recognize the larger number of plausible breaks in growth series of the sample countries. Moreover, as it is difficult for the countries to attain an up break following a growth acceleration (rapid or miracle growth) or a down break following a growth deceleration (recession or disaster), this approach explicitly allows to recognize a non-linearity in the growth process. This helps to obtain a perodization of growth regimes that are consistent with the historical understanding of economic growth across countries [121].

The Bai and Perron technique (2003) [29] involves two steps. In the first step maximum number of breaks are estimated given the minimum length of growth

regimes and length of the data series. Sequential testing for the optimal number of statistical significant breaks is done in the second step. The poor power of the BP test, in the second step of statistical testing procedure, leads to the rejection of a large number of "true" breaks. As suggested by Kar et al.(2013) [121] an alternative two step method "Fit and Filter", which is more broad based and provides an identification mechanism to capture a larger number of true breaks, is used. The potential breaks are identified in the first step by using the BP estimation technique. In the second step, instead of using the statistical procedure to confirm a genuine break, considered economic filters are applied.

In this work the dynamic programming algorithm as proposed by Bai and Perron is used to estimate the maximum number of breaks, which are partly determined by the available length of data series and partly by the minimum length of growth regimes also called trimming factor or bandwidth and denoted by h. The minimum fraction of observations allocated to any one segment is $\epsilon = h/T$, where T is the sample size and h is the minimum number of observations per segment. The potential breaks are estimated by assuming various trimming parameters (6 and 8 years). The choice of the periods is subjective, but the shorter periods, for instance, 3 to 5 years tends to conflate with short run shocks (e.g. earth quakes, droughts and floods) or business cycle fluctuations. A choice of a longer period could lead to missing true breaks and reduces the number of potential breaks. Table 2.1 presents the maximum number of plausible breaks postulated for each country depending on the length of available data series and the minimum length of a growth regime.

After estimating the potential breaks by using the first step of BP methodology, the genuine breaks are confirmed using a variant of FF methodology [121]. This technique is different from the earlier methods as it recognizes non linearity in growth dynamics . After achieving a positive growth break it becomes difficult for a country to sufficiently increase the growth rates to attain another transition of

Table 2.1: Maximum Number of Candidate Breaks for each Country

	Triming factor h (years)	
	8	6
More than 20 years and upto 30 years	1	2
More than 30 years and upto 40 years	3	4
More than 40 years and upto 50 years	4	6
More than 50 years and upto 60 years	5	7
More than 60 years and upto 65 years	6	9

same or high magnitude. Similarly, it is hard for a country to get another negative break of similar or high magnitude after incurring a negative growth transition. Following the Kar et al.(2013), it is logical to consider a smaller increase (decrease) in growth rates as an positive (negative) break followed by the up (down) break. The filters applied in this work to determine the breaks are as follows:

i. In case of first potential break (positive or negative), since it is not known whether it follows an acceleration or deceleration, any change of more than 2% is considered as a growth break.

   The breaks after that are determined on the basis of previous history.

ii. The absolute magnitude of the growth difference is considered to be 2% to qualify as a genuine growth break:

   a. if a possible acceleration follows a previous negative break or a candidate deceleration follows a positive break.

   b. if a possible positive break follows a previous acceleration or a candidate deceleration follows a negative break.

2.2.2 Non-Parametric Growth Accounting

A non-parametric growth accounting approach is used in the current work to measure the contribution of factors accumulation, production efficiency changes and technological progress in growth series transitions. Färe et al.(1994) [80] constructed the worldwide production frontier and associated efficiency levels of the individual economies (distances from the frontier) by using the work of the pioneers in this field, Farrell (1957) [81] and Afriat (1972) [8].

2.2.2.1 Data Envelopment Analysis (DEA)

DEA is a non-parametric methodology developed by Charnes et al.(1978) [61], which uses the multiple inputs and outputs to measure an entity's performance in the absence of market prices. It is used to measure the efficiency of decision making units (DMUs) and to evaluate their relative importance [158]. The basic approach is to envelop the data in the smallest and the tightest fitting convex cone. The upper boundary of this set gives the "best practice" production function. The defined benchmark technology is used to measure the efficiency of a decision making unit (country in the current work). This data-driven approach is implemented by the standard mathematical programming algorithms, based on the following weak assumptions:

- Production possibility curve is a convex cone.
- The inputs and outputs are freely disposable.
- All observable input-output combinations are feasible.
- The production technology is of constant returns to scale.

In present work the technology consists of four macroeconomic variables: GDP as aggregate output whereas labor, physical capital and human capital as three

aggregate inputs. Let $(Y_{it}, L_{it}, K_{it}, H_{it})$, $t = 1, 2, ..., T., i = 1, 2, ...I.$, represent T observations on these four variables for each of the I countries. The human capital is assumed to enter the technology as a multiplicative augmentation of physical labor[1]. So IT observations are $Y_{it}, \hat{L}_{it}, K_{it}$, $t = 1, 2, ..., T.$, $i = 1, 2, ..., I.$, where $\hat{L}_{it} = H_{it}L_{it}$ is the amount of labor input measured in efficiency units in a country i at time t [108].

For the production frontier calculations in period t, the inter-temporal variant of DEA that takes into account all input-output bundles that have ever been observed until period t is preferred as it precludes the technological regress[2].

Constructing the period t constant returns to scale technology using all data up to that point in time:

$$\tau_t = \{(Y, \hat{L}, K) \in \Re^3_+ \mid Y \leqslant \sum_{\tau \leqslant t} \sum_i \mu_{i\tau} Y_{i\tau} \wedge K \geq \sum_{\tau \leqslant t} \sum_i \mu_{i\tau} K_{i\tau} \wedge \hat{L} \geq \sum_{\tau \leqslant t} \sum_i \mu_{i\tau} \hat{L}_{i\tau}, \mu_{i\tau} \geq 0 \forall i, \tau\}$$

This is the Farrell technology cone. The upper boundary of the set is the best practice production frontier. It is typical that not all the decision making units produce on the technology set boundaries. In other words, such DMU's are inefficient as they are producing same output using more inputs. The Farrell output

[1] As in macroeconomic literature, the standard approach assumes implicitly that labor with different amounts of human capital, for example, skilled and unskilled labor are perfect substitutes although there are some evidences that this might not be a good assumption [4, 107, 108].

[2] The world technology frontier, independently calculated in each time period, can implode if the frontier defining countries experience the economic collapse. The difference between the observed production and production possibilities is important as there may be many events that can stop the countries from producing on the technology frontier. It is not possible to pin down all the events where once discovered production efficiency is forgotten [71, 108, 122].

based measure of technical efficiency for country i at time t is defined by:

$$E(Y_{it}, \hat{L}_{it}, K_{it}) = \min \left\{ e_{it} | \langle Y_{it}/e_{it}, \hat{L}_{it}, K_{it} \rangle \in \tau_t \right\}$$

This efficiency index is the inverse of the maximal proportional amount by which the output Y_{it} can be expanded while remaining technologically feasible, given the input quantities $\hat{L}_{it}$ and K_{it} and the technology τ_t. It is less than or equal to 1 and it takes the value of 1 if and only if the it observation is on the period t production frontier. Formally, the following linear programs are solved for every decision making unit to calculate the efficiency estimates:

$$\begin{aligned} \text{minimize } e_{it} \qquad \text{s. t.} \qquad \frac{Y_{it}}{e_{it}} &\leqslant \sum_{\tau \leqslant t} \sum_{i} \mu_{i\tau} Y_{i\tau} \\ K_{i\tau} &\geqslant \sum_{\tau \leqslant t} \sum_{i} \mu_{i\tau} K_{i\tau} \\ \hat{L}_{i\tau} &\geqslant \sum_{\tau \leqslant t} \sum_{i} \mu_{i\tau} \hat{L}_{i\tau} \\ \mu_{i\tau} &\geqslant 0 \quad \forall i, \tau \end{aligned}$$

For every decision making unit these efficiency levels e_{it} and the activity levels $\mu_{i\tau}$ are reported as the output of DEA analysis [80, 108].

2.2.3 Productivity Growth Decomposition

Since Data Envelopment Efficiency method explicitly allows for the possibility of non-efficient production, catch up growth due to the efficiency improvements and growth due to the innovations can be distinguished [123]. Research efforts are also focused to investigate causes of productivity change and its decomposition. Färe et al.(1994) [80] showed how to account for the productivity changes over time based on the Malmquist productivity index [57]. Kumar and Russel (KR) (2002)

[134], under the assumption of constant returns to scale decomposed the changes in income per worker into efficiency change, technological change and capital accumulation components. Such decompositions promote better understanding of the determinants of better performance and provide private and public sector managers and planners with the valuable information.

2.2.3.1 Malmquist Productivity Index

Malmquist productivity indices were introduced by Caves et al.(1982) [57] and they named it after Malmquist who proposed to use the ratios of distance functions as input quantity indices. The output oriented augmentation is discussed below.

The technology of production $T(x)$ contains all technically feasible input- output vectors for a certain production process[85].

$$T(x) = \{y : (x, y) \in T\}$$

For every $x \in \Re_+^N$ has output isoquants:

$$I(x) = \{y : y \in T(x),\ ey \notin T(x),\ e > 1\}$$

The output efficient subsets are

$$E(x) = \left\{y : y \in T(x),\ y^{'} \notin T(x),\ y^{'} \geqslant y\right\}$$

where the three sets satisfy $E(x) \subseteq I(x) \subseteq T(x)$.

The Shephard (1971) [195] output distance function $D_o(x, y)$ is defined on technology $T(x)$

$$D_o(x, y) = \mathbf{min}\,\{e : (x, y/e) \in T(x)\}$$

For $y \in T(x)$, $D_o(x, y) \leqq 1$ and for $y \in I(x)$, $D_o(x, y) = 1$. Under standard assumptions on T, the output distance function $D_o(x, y)$ is non-decreasing, convex and homogeneous of degree $+1$ in y and is non-increasing in x.

In simple case of one input and output, productivity change is defined as ratios of average products[3] [78],

$$\text{productivity change} = \frac{y^{t+1}/x^{t+1}}{y^t/x^t}$$

and can be expressed as the ratio of output distance functions under the constant returns to scale.

$$\frac{y^{t+1}/x^{t+1}}{y^t/x^t} = \frac{(y^{t+1}/x^{t+1})D_o(1,1)}{(y^t/x^t)D_o(0,0)} = \frac{D_o(x^{t+1}, y^{t+1})}{D_o(x^t, y^t)}$$

The two Malmquist (output oriented) productivity indices for the reference technology T^t and T^{t+1} can be defined as [57]

$$M_o^t = \frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)}$$

$$M_o^{t+1} = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)}$$

As in Färe et al.(1992) [79] by taking the geometric mean of the two indices, which is in the spirit of Fisher (1922) [84] who defined his ideal price index as the

[3]The Shepard output distance function allows to "aggregate" inputs and outputs, as a generalization of the production function to multiple outputs.

geometric mean of the Laspeyers and Paasche indices:

$$M_o(x^t, y^t, x^{t+1}, y^{t+1}) = (M_o^t . M_o^{t+1})^{1/2} = \left(\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)} \right)^{1/2}$$

By rearranging the above expression, component distance functions readily allow identification of efficiency change and technological change that is a movement towards the frontier and a shift in the frontier respectively:

$$M_o(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \left(\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right)^{1/2}$$

$$\text{so that} \qquad M_o(x^t, y^t, x^{t+1}, y^{t+1}) = EFFCH \times TECH$$

The evaluation of the index and its components requires the solution of four linear programming problems for each DMU, for each pair of year, t and $t+1$.

2.2.3.2 Quadripartite Decomposition

Under the constant returns to scale assumption the production process is expressed in space (k, y) by a function $y(k)$, where $y = Y/\hat{L}$ and $k = K/\hat{L}$ are the ratios of output and capital to labor input measured in efficiency units, respectively [26]. The considered economy is assumed to produce output y_b at a point b in the base period using the capital intensity k_b and output y_c at point c in the current period using capital intensity k_c.

By definition output on the production frontier for the respective capital intensities is given by $\bar{y}_b(k_b) = y_b/e_b$ and $\bar{y}_c(k_c) = y_c/e_c$, where e_b and e_c are the respective periods efficiency scores. The two periods income per worker is related by

$$\frac{y_c}{y_b} = \frac{e_c}{e_b} \frac{\bar{y}_c(k_c)}{\bar{y}_b(k_b)}$$

Multiplying both the numerator and the denominator by $\bar{y}_b(k_c)$ or $\bar{y}_c(k_b)$ and rearranging the terms will result in the following equations, which under the Hicks-neutral give the same results.

$$\frac{y_c}{y_b} = \frac{e_c}{e_b} \frac{\bar{y}_c(k_c)}{\bar{y}_b(k_c)} \frac{\bar{y}_b(k_c)}{\bar{y}_b(k_b)}$$

$$\frac{y_c}{y_b} = \frac{e_c}{e_b} \frac{\bar{y}_c(k_b)}{\bar{y}_b(k_b)} \frac{\bar{y}_c(k_c)}{\bar{y}_c(k_b)}$$

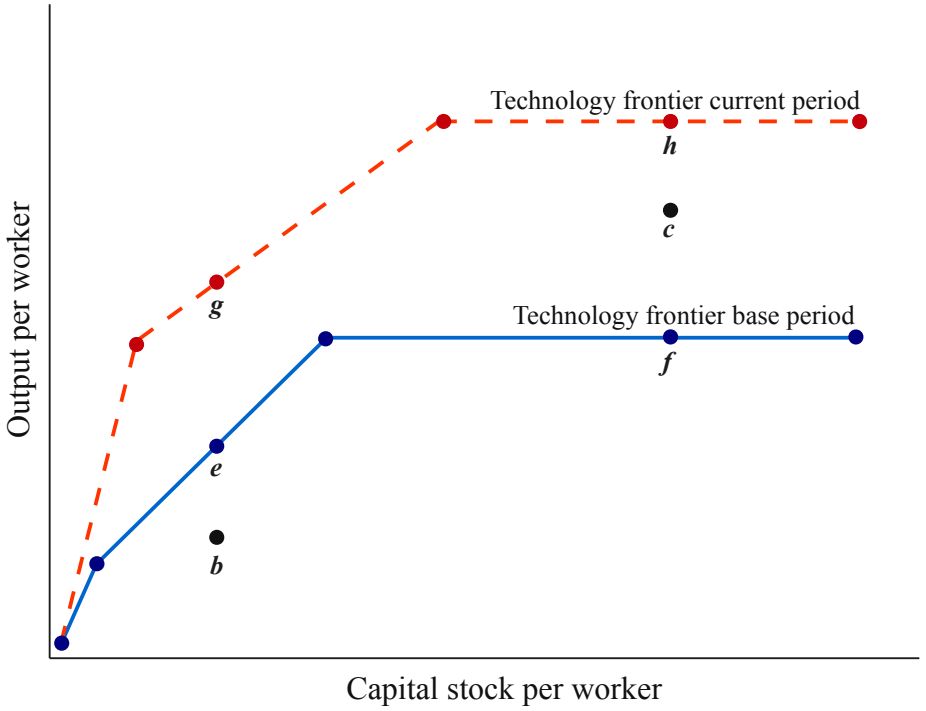
Graphically, as shown in figure 2.2, the proposed decomposition measures the changes in efficiency as the catch-up movement from point b to point e, technological changes by shifts of the current frontier from point f to point h and the capital accumulation effect by movements along the base period frontier from e to f. The reverse decomposition from current period to base period is also possible [123].

The Fisher ideal decomposition, which uses the geometric averages of the measures of technological change and accumulation, is applied to avoid the ambiguity of the path dependence (base period or current period frontier) or neutrality of the technological change. Formally

$$\frac{y_c}{y_b} = \frac{e_c}{e_b} \left(\frac{\bar{y}_c(k_c)}{\bar{y}_b(k_c)} \frac{\bar{y}_c(k_b)}{\bar{y}_b(k_b)} \right)^{1/2} \left(\frac{\bar{y}_b(k_c)}{\bar{y}_b(k_b)} \frac{\bar{y}_c(k_c)}{\bar{y}_c(k_b)} \right)^{1/2}$$

where the first term denotes efficiency change (EFF), second technological change (TECH) and the third term gives the effect of the capital deepening (KACC).

FIGURE 2.2: Illustration of Non-Parametric Growth Accounting. [122]



The growth of the productivity $\hat{y}_t = Y_t/L_t$ can be decomposed into the growth of output per efficiency unit of the labor and the growth of human capital as follows:

$$\frac{\hat{y}_c}{\hat{y}_b} = \frac{y_c}{y_b}\frac{H_c}{H_b}$$

$$\frac{\hat{y}_c}{\hat{y}_b} = \frac{e_c}{e_b}\left(\frac{\bar{y}_c(k_c)}{\bar{y}_b(k_c)}\frac{\bar{y}_c(k_b)}{\bar{y}_b(k_b)}\right)^{1/2}\left(\frac{\bar{y}_b(k_c)}{\bar{y}_b(k_b)}\frac{\bar{y}_c(k_c)}{\bar{y}_c(k_b)}\right)^{1/2}\frac{H_c}{H_b} \tag{2.1}$$

$$\frac{\hat{y}_c}{\hat{y}_b} = EFF\,.\,TECH\,.\,KACC\,.\,HACC$$

where $HACC$ is the human capital accumulation.

For the decomposition calculation the needed distance functions are be defined as:

$$D_o^b(k_b, y_b) = \frac{y_b(k_b)}{\bar{y}_b(k_b)} = \frac{Y_b(K_b, \hat{L}_b)}{\bar{Y}_b(K_b, \hat{L}_b)}$$

$$D_o^c(k_c, y_c) = \frac{y_c(k_c)}{\bar{y}_c(k_c)} = \frac{Y_c(K_c, \hat{L}_c)}{\bar{Y}_c(K_c, \hat{L}_c)}$$

The additional distance functions giving the efficiency of today's production in reference to tomorrow's technology frontier and the efficiency of tomorrow's production in reference to today's technology frontier are needed. These distance functions are also obtained by solving two additional linear programs.

$$D_o^c(k_b, y_b) = \frac{y_b(k_b)}{\bar{y}_c(k_b)}$$

$$D_o^b(k_c, y_c) = \frac{y_c(k_c)}{\bar{y}_b(k_c)}$$

The first term defining efficiency in equation 2.1 in terms of distance function is expressed below[122].

$$\frac{e_c}{e_b} = \frac{D^c(k_c, y_c)}{D^b(k_b, y_b)}$$

The technological change can be written as:

$$\left(\frac{\bar{y}_c(k_c)}{\bar{y}_b(k_c)}\frac{\bar{y}_c(k_b)}{\bar{y}_b(k_b)}\right)^{1/2} = \left(\frac{\frac{1}{\bar{y}_b(k_c)}y_c(k_c)}{\frac{1}{\bar{y}_c(k_c)}y_c(k_c)}\frac{\frac{1}{\bar{y}_b(k_b)}y_b(k_b)}{\frac{1}{\bar{y}_c(k_b)}y_b(k_b)}\right)^{1/2}$$

$$= \left(\frac{D^b(k_c, y_c)}{D^c(k_c, y_c)} \frac{D^b(k_b, y_b)}{D^c(k_b, y_b)} \right)^{1/2}$$

The capital deepening effect can be expressed as:

$$\left(\frac{\bar{y}_b(k_c)}{\bar{y}_b(k_b)} \frac{\bar{y}_c(k_c)}{\bar{y}_c(k_b)} \right)^{1/2} = \left(\frac{\frac{1}{\bar{y}_b(k_b)} \frac{y_b(k_b)}{y_b(k_b)}}{\frac{1}{\bar{y}_b(k_c)} \frac{y_c(k_c)}{y_c(k_c)}} \frac{\frac{1}{\bar{y}_c(k_b)} \frac{y_b(k_b)}{y_b(k_b)}}{\frac{1}{\bar{y}_c(k_c)} \frac{y_c(k_c)}{y_c(k_c)}} \right)^{1/2}$$

$$= \left(\frac{D^b(k_b, y_b)}{D^b(k_c, y_c)} \frac{D^c(k_b, y_b)}{D^c(k_c, y_c)} \left(\frac{y_c}{y_b} \right)^2 \right)^{1/2}$$

2.3 Data

The data for both, the determination of structural breaks and non-parametric growth accounting, is taken from Penn World table version 9.0. PWT is being the standard source of data on real GDP across countries. By making use of the across countries collected prices in Benchmark year by International Comparisons Program (ICP), PWT constructs the purchasing-power-parity exchange rates and converts the GDP at national prices to a common currency - US dollars- thus making them comparable across countries. The yearly data of percentage change in real GDP per capita (rgdpna: Real GDP at constant 2011 national prices (in mil. 2011 US dollar), and pop: Population in millions) for 180 countries from 1950 to 2014 with atleast 25 years of data to identify the genuine structural breaks in growth series is used. Real GDP at national prices is used to identify the structural breaks in growth series as it helps to compare the growth rates across countries.

The data for non-parametric growth accounting includes: Real GDP (rgdpo: Output-side real GDP (at Chained PPPs in mil. US dollar)), physical capital (rkna: Capital stock at constant 2011 national prices (in mil. 2011 US dollar)), based on investment and prices of structures and equipment[82]), human capital (hc: Index of human capital per person) based on years of schooling and returns to education and labor (emp: Number of persons engaged (in millions)). Output side real GDP is employed to compare relative productive capacity across countries and over time.

2.4 Results and Discussion

Based on the methodologies and data description in previous sections, the estimated results are presented for the identified structural breaks in growth series

and for the decomposition of productivity changes around the structural breaks, respectively. The *strucchange package* in R statistical software is used to calculate the candidate breaks using the Bai & Perron methodology. Moreover, for the non-parametric growth accounting analysis the *FEAR package*, also in R statistical software, is used.

2.4.1 Structural Breaks

The genuine structural breaks in the growth series of 180 countries are identified by using a variant of unified Fit and Filter approach as discussed in section 2.2.1. The number of breaks in the beginning and at the end of growth series is low by construction due to the considered trimming factor. For the time series starting from 1950 to 2014, the earliest possible break is 1958 (1956) and the latest is 2006 (2008), considering eight (six) years minimum duration[4].

There are two salient features of the fit and filter methodology. Firstly, this technique allows to identify the break, whenever, there is a change in growth rates of certain magnitude, whereas, in BP methodology the potential break is identified as a break only when the change in growth is statistically significant, thus making it difficult to identify breaks on fluctuating and volatile growth paths. Secondly, due to an explicit recognition of non linearity in growth dynamics more breaks are identified. The FF technique uses different filters for the potential breaks after considering the nature of last actual break. For instance, any up-break (down-break) can be identified as the genuine break if it is 2 percentage point higher (lower) than the previous growth regime. Kar et al.(2013) [121] argued that these are the real miracles as for a developing country the crucial relevance of these transitions from high to higher growth rates can be hardly overemphasized. Kar et al.(2013) [121] showed that by using BP technique almost quarter of the breaks are identified from

[4]Appendix A.1 shows the list of considered countries with FF breaks (h=8)

Europe, due to the nature of this methodology which picks up breaks more easily from the steady growth series. Whereas, the FF methodology is more successful in identifying the structural breaks in case of volatile and fluctuating growth series.

Figures 2.3 and 2.4 compare the region-wise breaks identified using both FF and BP methodologies considering the trimming factors 6 and 8 respectively[5]. In total, for both of the trimming factors ($h = 6$ and 8), the number of genuine breaks estimated by using the FF technique (782+546=1328) are roughly 4 times more than the breaks identified by BP methodology (180+154=344). The findings in this study are in line with the previous researches in identifying more breaks for the volatile growth series of African and Asian developing countries. The number of breaks identified by FF approach for lower and lower middle income economies in Africa and Asia are roughly four times more than the BP technique, showing that the former approach supports recognition of the genuine breaks even in highly fluctuating growth series. Moreover, for the developed economies of Europe with relatively smooth growth series, the FF methodology assists in finding genuine breaks accounting approximately 17% of the total breaks which are less as compared to the BP technique (identifies more than 26% breaks).

[5]North America also includes Caribbean and Central American Countries.

Figures 2.5, 2.6, 2.7 and 2.8 show the estimated de'cadel structural break results summarized region-wise for positive and negative breaks. A break is said to be positive if it is followed by the 2% increase in average growth rate compared to the one before the break and vice versa. For growth regime lasting for the minimum period of 8 years, the number of positive breaks is 271 and the number of up-breaks in case of $h = 6$ is 380. The studies by Berg et al.(2012) [44], Jones and Olken (2008) [118], or by Kerekes (2011) [123] showed the concentration of breaks in 1970s and 1980s and also found a significant majority of the breaks during this period to be negative. The results in the present study show that about 40% of the breaks for the considered time period come from these two decades. Moreover, results for the decade 1970-79 show that the negative breaks exceed the positive ones. The recorded number of negative breaks in 1970s is in accordance with the happening of productivity slow down in the industrialized world. However, contrary to many previous studies the majority of breaks (for both $h = 6$ and $h = 8$) during 1980s and 1990s are found to be positive which go with the findings of Kar et al.(2013) [121]. The number of negative breaks exceed the up-breaks for the years from 2000 to 2009, pertaining to the decline in economic activities, occurred mainly in developed economies.

Figures 2.5, 2.6, 2.7 and 2.8 also show that African, South American and Oceania regions experienced more growth accelerations than growth deceleration whereas, for Asia the number of both positive and negative breaks are almost the same. However, in Europe and North & Central American countries the number of negative breaks exceeds the positive breaks. The African economies showed stable growth paths during 1950s with a few structural breaks. However, after 60's the deterioration in both economic and political situation led to slow growth, whereas, from 1990s to present the African countries are showing sustained and increasing growth rates with more positive leaps. The number of positive breaks during 1990's for European countries is high. The treaty of European Union was signed in 1992, moreover, the single market and its four freedoms (the free movement of goods, services, people and money) were also settled in 1993. However, during

the first decade of a new century the number of down-breaks exceed the positive regime shifts in particular, for the trimming factor 6, which includes period of financial crises, starting from summer 2007.

The regime shifts occur in all regions of the world and 58% of the total structural breaks occurred in Asia and Africa[6]. The table 2.2 shows the region wise classification of the structural breaks considering the state of development of respective countries for the trimming factor 8. The countries are categorized by using United Nations Development Programme's (UNDP) Human Development Report. The human development index (HDI) is used as it consolidates the three main aspects of human development and welfare. For instance, modest standard of living is depicted by the level of Gross National Income per Capita. Ability to acquire skills and knowledge is captured by using the mean and expected years of schooling. Moreover, healthy and long life is reflected by life expectancy at birth. The countries fall into four broad human development groups; very high human development (vhd)with more than 0.80 index points, high human development (hd) with more than 0.70 index points, medium human development (md) with more than 0.55 index points and low human development (ld) with less than 0.55 index points. The African continent which is traditionally considered to have unfathomable growth records shows more number of positive breaks, in total, as compared to the developed economies of Europe and North & Central America with more down breaks.

In lower part of table 2.2 the overall aggregates for various human development levels are presented. Around 72% of total breaks occurred in the countries with human development index below 0.80 (hd, md and ld) which is in accordance with the fact that developing economies experience different growth regimes (accelerations or deceleration) and frequently shift from one growth regime to another. Moreover, for each medium human developed (md) country more than 68% of the

[6]Appendix A.2: State of Development (region-wise) Quadripartite Decomposition Indices

breaks are positive, suggesting that its not the growth trap in which the md countries are stuck rather its the matter of sustainability of positive growth regime once achieved [44, 105, 115]. However, for low human developed countries (ld), mainly from Africa, the number of negative breaks exceed. There can be several reasons for more negative growth transitions among ld countries, for instance, economic and political situation, natural resource trap and reliance on foreign debt, etc.

TABLE 2.2: State of Development and Structural Breaks (h=8)

Region		VHD	HD	MD	LD	Total
Africa	Positive	0	10	64	23	97
	Negative	0	6	23	57	86
	Total	0	16	87	80	183
	No. of Countries	0	4	13	33	50
Asia	Positive	16	25	24	2	67
	Negative	25	22	16	4	67
	Total	41	47	40	6	134
	No. of Countries	14	16	16	2	48
Europe	Positive	31	9	1	0	41
	Negative	44	8	0	0	52
	Total	75	17	1	0	93
	No. of Countries	31	8	1	0	40
North &	Positive	9	22	6	1	38
Central	Negative	13	30	5	1	49
America	Total	22	52	11	2	87
	No. of Countries	9	15	4	1	29
South	Positive	6	11	6	0	23
America	Negative	4	11	3	0	18
	Total	10	22	9	0	41
	No. of Countries	2	6	2	0	10
Oceania	Positive	3	2	0	0	5
	Negative	2	1	0	0	3
	Total	5	3	0	0	8
	No. of Countries	2	1	0	0	3
Grand total	Positive	65	79	101	26	271
	Negative	88	78	47	62	275
	Total	153	157	148	88	546
	No. of Countries	58	50	36	36	180

2.4.2 Non-Parametric Growth Accounting

After the identification of the structural breaks in growth series of the countries, following calculations are done to get the quadripartite decomposition of the productivity changes by using trimming factor 8. Due to data restrictions the total number of countries considered in non- parametric growth analysis is 144[7]. The inter-temporal variant of DEA, that takes into account all input- output bundles until period t, is used, as it precludes the technological regress[8]. Consider the break occurring in the year **s**. For every adjacent pair of years in five years before and five years after the break in GDP growth series, the components of productivity growth, for instance, efficiency change, technological progress and changes resulting from capital deepening and human capital accumulation are calculated. The averages of growth factors for the period, five years before and five years after the break, are calculated which are reduced by 1 and multiplied by 100[9]. Finally, the overall averages of the components across the countries are obtained. Moreover, the growth of human capital is calculated as the quotient of averages five years after and five years before the breaks for each break. Thus, positive (negative) values indicate increase (decrease) in the growth factors.

The summarized results of productivity growth decomposition around the upbreaks are presented in the table 2.3. The first column shows the non-parametric estimates of growth before the positive break, whereas, the second column shows after the break estimations. The average GDP growth exhibits the positive jump of

[7]Due to missing data on human capital Aruba, Anguilla, Antigua & Barbuda, Azerbaijan, Bahamas, Bosnia and Herzegovina, Belarus, Bermuda, Bhutan, British Virgin Islands, Comoros, Cape Verde, Cayman Islands, Chad, Djibouti, Dominica, Georgia, Equatorial Guinea, Guinea, Guinea Bissau, Grenada, Lebanon, Macedonia, Montenegro, Montserrat, Oman, State of Palestine, Sao Tome & Principe, Seychelles, Suriname, St.Kitts & Nevis, St.Lucia, St.Vincent, Turks and Caicos Islands, Turkmenistan and Uzbekistan are excluded from the further analysis.

[8]The results presented here are calculated by using the preceding five years input-output bundles.

[9]For example, if the break is in year 1970, the regime before and after the break is g66,....,g70 and g71,...., g75, respectively where g66 is the growth in 1965-1966

approximately 5% after the up-break. Other components are also increasing positively after the positive breaks. The efficiency change contribution to observed growth rate gets positive after the break. The difference in the percentage points between the regimes is 3.13 and 0.50 for efficiency and technological changes, respectively. In case of up-breaks efficiency improvements contribute more than half of the total productivity growth. Moreover, capital deepening contributes positively by more than one percentage point after the regime change. The impact of human capital accumulation growth is also positive on productivity growth. The positive change of about 40% in productivity growth after growth acceleration is contributed by the latter two factors.

Table 2.4 presents the summarized results of productivity growth decomposition around the down-breaks. The GDP growth rate falls from 6.97 to 2.61 between the regimes. The negative efficiency before the down break, tends to be more negative after the deceleration in growth series. Technological change also contributes negatively to productivity growth after the down breaks and its share (more than 25%) is relatively higher than the up-breaks. The growth contribution of the capital deepening is fallen from 5.42 to 4.34 percentage points after the negative breaks and causes decline in productivity growth. However, the growth of human capital accumulation tends to effect productivity growth positively.

Figures 2.9, and 2.10 presents the calculations for positive and negative regime shifts, respectively, by plotting the four productivity component growth rates against the year of break (five years averages before and after the breaks reduced by one and multiplied by 100). Panel a of figure 2.9 shows efficiency improvements at the occurrence of positive structural breaks. Moreover, in panel c the technological progress before and after the up-breaks suggests positive role of it. Ample dispersion of capital deepening and human capital accumulation is highlighted in panel b and panel d, respectively. However, their role get enhanced and more positive at the break points. The contribution of technical efficiency tends to be

TABLE 2.3: Positive breaks and Non-Parametric Growth Accounting

	Before	After	Difference
GDP growth	1.83	6.89	5.06
Efficiency change	-1.86	1.27	3.13
Technological change	1.01	1.51	0.50
Capital deepening	2.77	4.08	1.31
Human capital accumulation			1.16
Observations	224	224	

Figures are reported as an overall average across the countries which are reduced by 1 and multiplied by 100.

more negative at the down-breaks as depicted in the figure 2.10 panel a. The technological changes, presented in panel c, also tends to effect the productivity change negatively. Again in panel b and panel d, there are wide dispersion of contributions of human and capital accumulation, respectively. The role of capital deepening tends to be less positive at the down-breaks, whereas, the human capital accumulation effects productivity growth positively.

The respective importance of efficiency and technological changes, capital deepening and human capital accumulation for growth regime changes (up-breaks and

TABLE 2.4: Negative Breaks and Non-Parametric Growth Accounting

	Before	After	Difference
GDP growth	6.97	2.61	-4.36
Efficiency change	-0.45	-2.75	-2.30
Technological change	2.04	1.18	-0.86
Capital deepening	5.42	4.34	-1.08
Human capital accumulation			1.17
Observations	225	225	

Figures are reported as an overall average across the countries which are reduced by 1 and multiplied by 100.

down-breaks for trimming factor 8) of 144 countries at different states of human development is summarized in Table 2.5[10]. It shows that among various group of countries the sources of growth vary. The first part of table 2.5 deals with the up-breaks. More than one third of a productivity change is contributed by the total factor accumulation for all the states of development. The finding is quasi in line with the calculations of Henderson and Russell (2005) [108], who found that more than half of the mean productivity growth is attributed to the factor productivity

[10]The calculated differences are reported, by using the averages five years after and five years before the breaks which are reduced by 1 and multiplied by 100.

growth.They also pointed out that more than half of physical capital accumulation share in productivity growth, as highlighted by KR, was in-fact the result of human capital accumulation. In all the groups of countries the efficiency improvements followed by capital deepening and human capital accumulation contribute to growth acceleration. The growth improvements in ld countries is relatively more, about 62%, due to the efficiency improvements as compared to rest of the considered countries (accounting to forty percent and more). This shows the key importance of the reallocation of resources to positive growth spells. However, as described by Hausmann et al.(2005) [105] such changes are not enough to forecast positive growth without further information and explanations. Rodrick (2005) [185] also highlighted the fact that initializing of growth acceleration is different from sustaining it. The number of positive breaks for developing countries conclude that growth acceleration is conceivable by them and they are not stuck in the poverty trap. The problem is rather associated with their inability to sustain the growth accelerations. The growth rate after up-breaks is less explained by the technological changes particularly for md and ld countries, however, this confirms the finding of Kumar and Russel (2002)(KR) [134] that technological change is palpably non-neutral.

The lower panel of the table 2.5 presents the results for down-breaks at different states of human development. The decline in efficiency contributes mainly in growth deceleration for all states of development. The technological progress also plays negative role, moreover, its contribution in case of down-breaks is relatively higher for all states of development, except for less human developed countries, as compared to the positive breaks. The slower capital accumulation for all states of human development plays a negative role. However, as in the case of up-breaks the role of human capital accumulation in down-breaks is positive too. It is also relatively higher for the developing countries as compared to the developed economies, possibly due to more contribution of the workers in labor market to cope up with the individual income losses during the growth deceleration [123]. The contribution of total factors of productivity is less in down-breaks as compared to their

share in positive growth transitions.

Figures 2.11, and 2.12 present the decade-wise decomposition of productivity growth components sorted on regional basis for up and down breaks with trimming factor 8. For almost all the decades efficiency improvements (decline) effect the productivity growth positively (negatively). The technological change for the positive breaks during the 70's decade for all regions show negative impact on productivity growth. Based on the existing literature, the reasons behind this productivity slow down, could be the less share of traditional industrial setup, which was established mostly for the private consumption during that period. Moreover, the technological improvements, in the beginning, require more funds, investments, research, resources and also need some time to reap benefits. Besides, with the new technological improvements, the level of employment, considered to be one of the major measure of growth, did not increase rapidly which effects the economy negatively.

2.4.3 Discussion

There exists a large empirical literature that tried to identify the shifts in growth series. The literature can be classified using either of the two distinct approaches. Firstly, the subjective methodology, which defines the thresholds to determine the transitions in growth regime known as a filter approach (Hausmann et al.(2005)). Secondly, the statistical approach which uses estimation and testing procedure (Bai & Perron test) to identify the statistically significant breaks, for instance, studies done by Jones and Olken (2008) [118], Berg et al.(2012) [44] and Kerekes (2011) [123]. This research work uses a variant of unified approach known as Fit and Filter methodology, proposed by Kar et al.(2013) [121], to identify the transitions in growth regimes (both positive and negative). This technique combines both the aforementioned approaches to identify the break in growth series. This methodology helps to avoid weaknesses of the previous approaches. Firstly, by

TABLE 2.5: Development State and Non-parametric Growth Accounting

Positive breaks	VHD	HD	MD	LD
GDP growth	5.37	5.34	4.63	4.81
Efficiency change	3.29	2.65	2.89	3.68
Technological change	0.84	0.96	0.00	0.11
Capital deepening	1.12	1.60	1.66	0.89
Human capital accumulation	1.10	1.14	1.19	1.21
Observations	58	60	49	57
Down-breaks				
GDP growth	-3.93	-4.72	-4.88	-4.24
Efficiency change	-1.56	-2.18	-2.90	-3.03
Technological change	-1.59	-0.90	-0.41	-0.10
Capital deepening	-0.74	-1.57	-1.14	-0.99
Human capital accumulation	1.10	1.16	1.25	1.24
Observations	76	56	38	55

Figures are reported as an overall average across the countries. Here the difference figures, before and after the breaks, are reported.

avoiding inconsistencies and ad-hoc nature of filter approach. Secondly, by overcoming the problem of low statistical power of the BP methodology, which leads to the acceptance (rejection) of the structural breaks even when they are false (true) breaks. Larger number of candidate breaks is found by using FF technique from 180 countries data on GDP per capita growth for a period of 1950-2014 than by employing the pure statistical BP approach. Moreover, as compared to other studies which used pure statistical approach, more breaks are identified from the volatile growth series pertaining to the developing countries in general by applying FF methodology. The employed approach in this work also helps to identify the breaks leading countries to the higher levels of growth from previous high growth spans (rapid or miracle growth) and vice versa.

Total number of 546 structural breaks are found (271 positive and 275 negative in case of $h = 8$). The up-breaks are more common in the lower income, lower middle economies and upper middle income (193 up-breaks, h=8), contrary to the high income economies[11]. This confirms that the developing countries do not remain in the poverty trap, however, the sustainability of the positive growth once achieved is crucial. The variant of FF technique used in this paper helps to identify more number of breaks which are described as the "true negative" problems of the statistical approach. Moreover, as it is difficult for countries to show positive break following the growth acceleration or a down break following a growth deceleration, the adopted approach recognizes the non-linearity in the growth process. Thus, enabling periodization of growth regimes consistent with the historical understanding of economic growth across countries [121].

After the identification of structural breaks by using the unified FF technique in growth series, productivity growth is decomposed into the technical catch-up, technological progress and factor accumulation using a non-parametric growth

[11]The countries are categorized by using World Bank GNI per Capita Operational Guidelines & Analytical Classifications (Year 2014)

accounting approach. Previous literature generally suggested that the non- parametric growth accounting approach tends to find more impact of factor accumulation on productivity growth than its sources. However, the results in this work suggest that the non-parametric growth accounting tends to find role of factor accumulation along-with the sources of productivity growth. The calculated results show that the driving forces for growth accelerations and deceleration are efficiency changes along-with factors accumulation. Furthermore, the findings are partially in line with the results of Henderson and Russell (2005) [108] and Jerzmanowski (2006) [115]. The contribution of efficiency improvements in up-breaks and growth accelerations is dominant. The role of factor accumulation is also important, where in case of the up-breaks, the share of human capital accumulation is more than 45% of the contribution of factors accumulation in productivity growth. As pointed by Henderson and Russell (2005) [108], these results suggest the importance of capital deepening and human capital accumulation on productivity growth. The key player in the growth slow down is decline in efficiency followed by the negative impact of capital deepening. However, the magnitude of the contribution of factor accumulation in both positive and negative regimes is different. For positive breaks it accounts for more than 40% whereas, it is only 3% in growth deceleration. This asymmetry requires separate modeling frameworks for positive and negative growth transitions. In case of down-breaks the role of technological change is relatively higher as compared to the up-breaks.

Considering the human development state of countries the role of efficiency tends to be dominant in both up and down breaks. In case of positive growth breaks the role of technological improvements is really meager and rather irrelevant for low and middle states of human development economies. However, for very high and high human development countries its role is positive and relatively high. In case of down-breaks, when the total impact of factor accumulation is taken into account, the contribution of technological decline gains relevance for the very high, high and medium human development countries. For low human development countries (ld) the major participant in the growth shifts (positive and negative) is

efficiency change. In this case, resource reallocation tends to be the most crucial aspect as it guides the lds to stay on positive growth track or helps to get out of the negative growth paths. However, this area requires further research and analysis, to be conducted on the individual countries, to figure out the suitable strategies and implementable policies.

2.5 Conclusions

The approach employed in this paper pays attention to the shifts in growth performance and the mystery of growth transition within a country and highlights the fact that average growth rates can mask very distinct growth paths. The current work also deals with the changes in productivity growth as a main source of growth regime transitions. The structural breaks in growth series are identified using the variant of unified fit and filter approach. This methodology allows to overcome the weaknesses of both statistical and filter based approaches. The identified structural breaks in growth series are used to decompose the productivity changes into efficiency and technological changes, capital deepening and human capital accumulation. The proximate sources of growth are determined by using non-parametric growth accounting technique, which requires fewer assumptions than the parametric growth accounting. Particularly, the functional form of the production function is not defined because of which the elasticity of substitution between the variables is estimated by the data, and also the market structure assumptions are not needed.

This paper confirms the findings of Jones and Olken (2008) [118] that capital deepening is not the main driver in growth rate changes. However, regarding human capital accumulation the results are in line with Henderson and Russel (2005) [108] findings who found that more than half of the increase in the mean productivity, attributed by KR to the physical capital accumulation, is in-fact due to the human capital accumulation. Following the conclusions by Jones and Olken (2008) and Kerekes (2011), the results also suggest that both positive and negative breaks are asymmetric, as in case of up-breaks the sources leading to productivity growth are mixed with efficiency improvements (as a main participant) followed by factor accumulation. However, in case of down-breaks the productivity slow-down is mainly the result of decline in efficiency. Moreover, the contribution of capital accumulation in both cases is substantially the same but in opposite directions.

In case of developing countries the role of efficiency is really important. Therefore, the reallocation of the resources can lead to growth improvements. Although, improvement in efficiency, only, is not sufficient to predict about the future growth [105], it can be one direction to work on. By reallocating the resources of production efficiently, at some point the country can switch to either capital accumulation or technological improvements (innovations). The poor countries inability to sustain the positive breaks in growth can be the reason to not to undergo this change [185].

The direction of further research can be the in-depth analysis of the individual sources of productivity growth. As the results show that growth transition is mostly dominated by the efficiency change, next step can be the study of sources of efficiency change. The more thorough understanding of the determinants and sources of the production efficiency can help to identify the reasons of poverty of countries and guide the way to make suitable policies for countries to get on prosperity track.

FIGURE 2.3: Fit & Filter vs Bai & Perron Breaks (h=6)

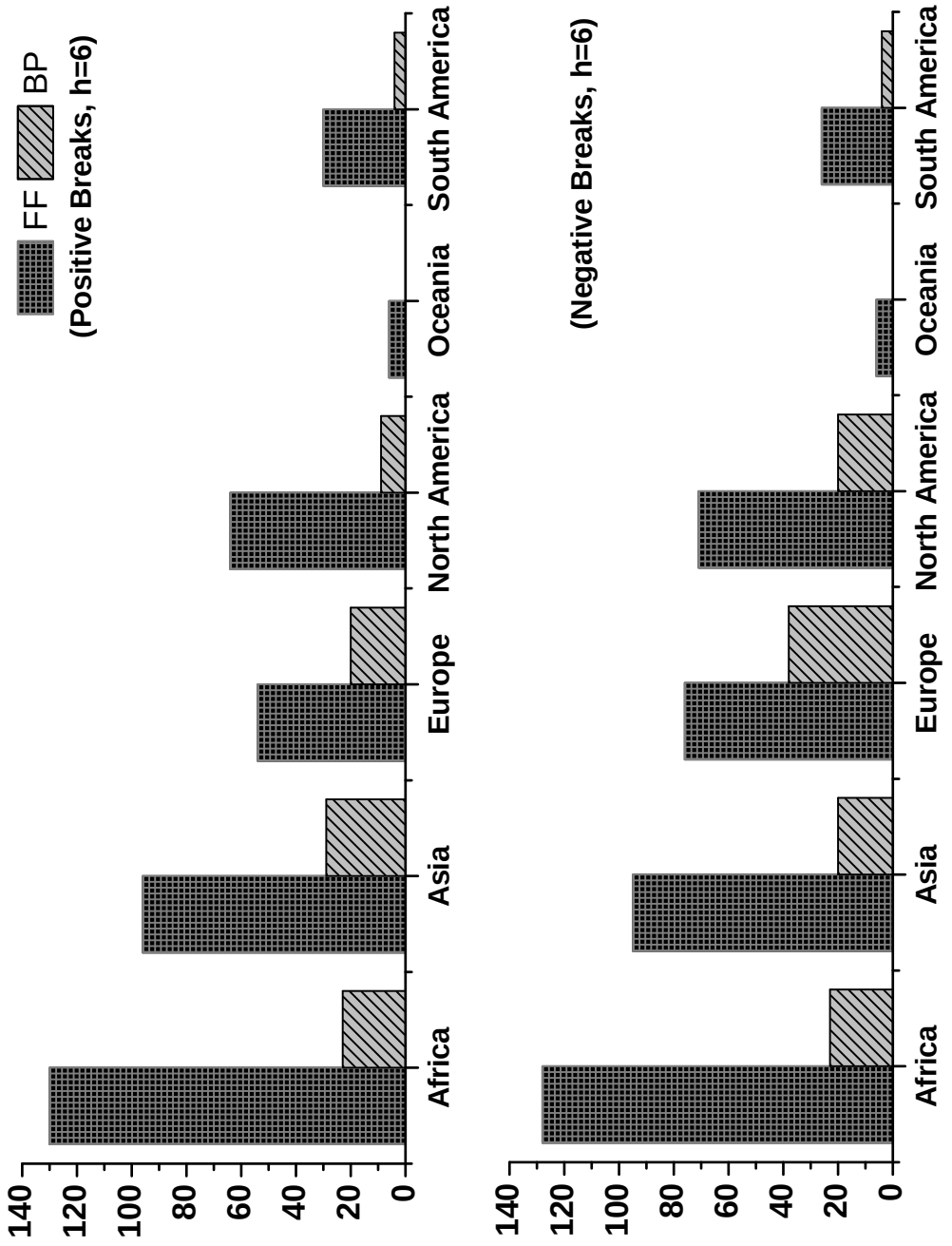


FIGURE 2.4: Fit & Filter vs Bai & Perron Breaks (h=8)

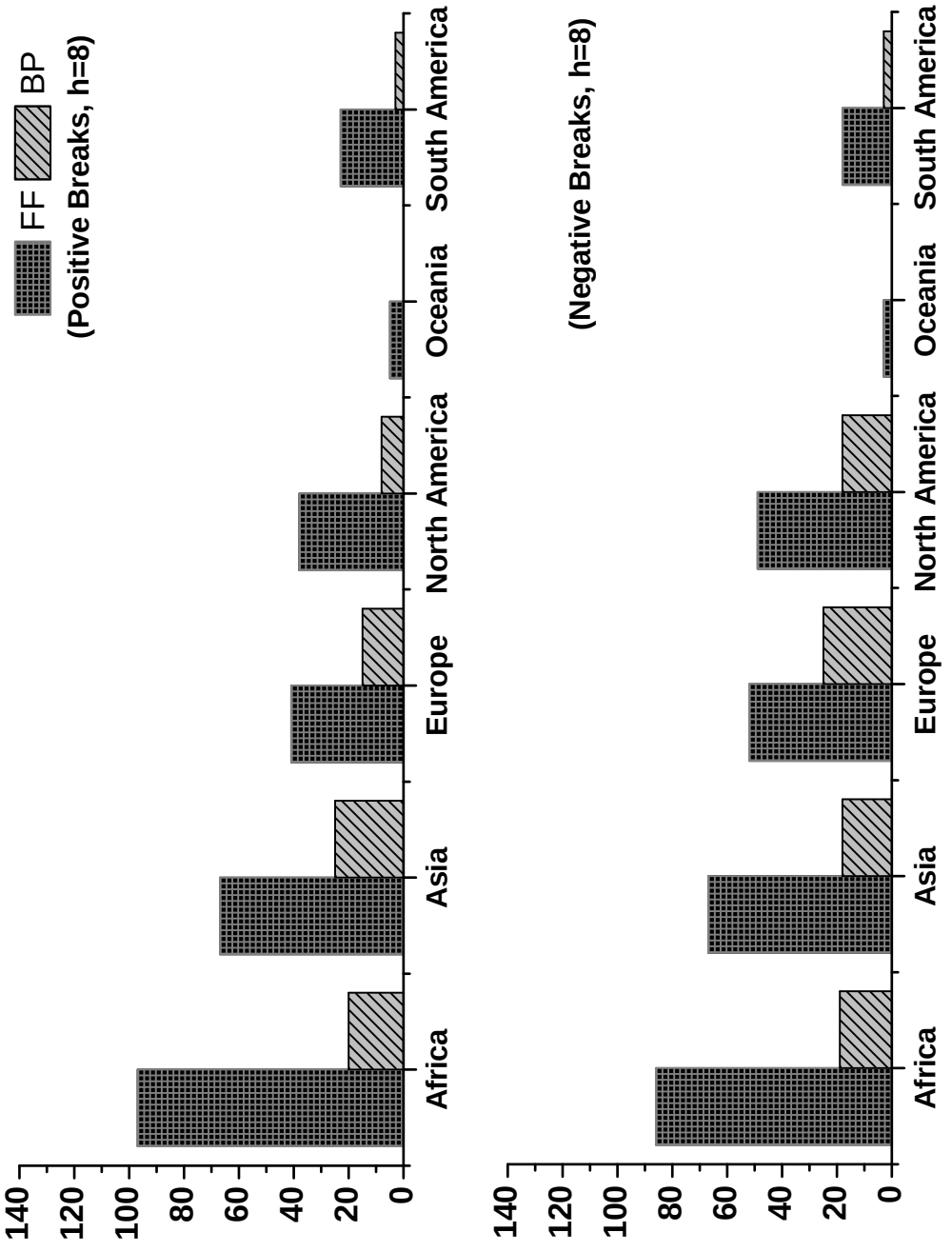


FIGURE 2.5: Decade-wise Regional Positive Breaks (h=6)

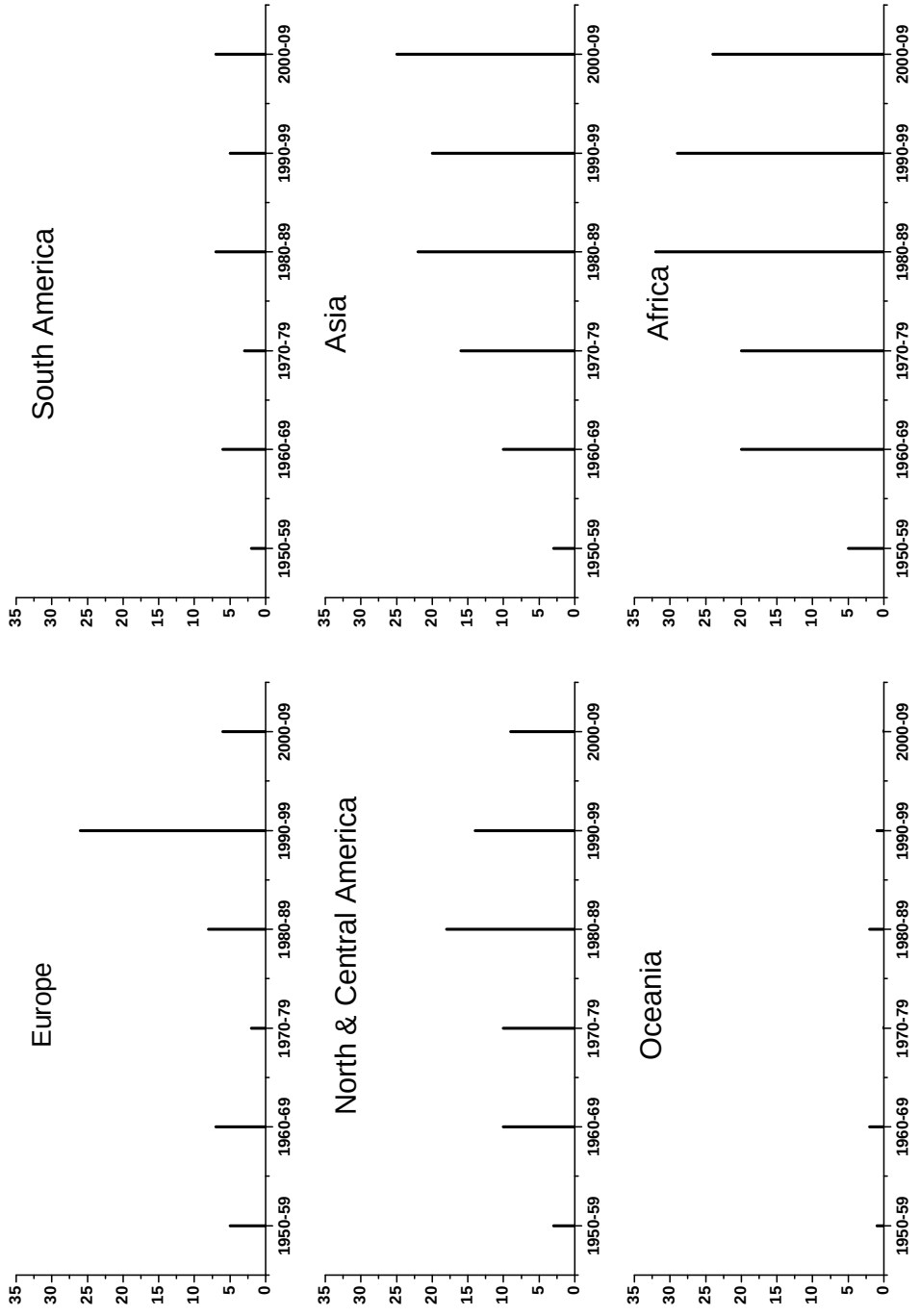


FIGURE 2.6: Decade-wise Regional Negative Breaks (h=6)

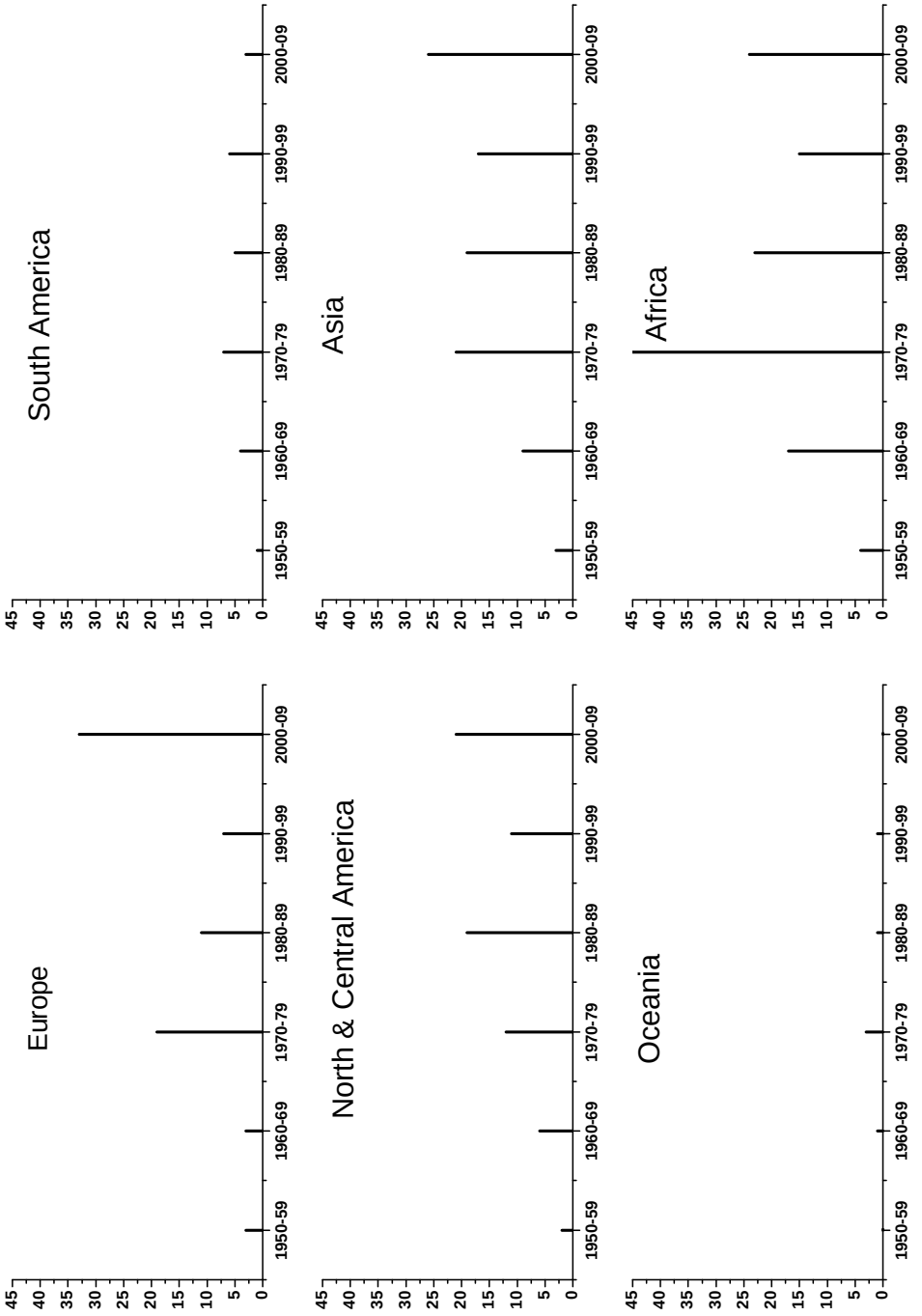


FIGURE 2.7: Decade-wise Regional Positive Breaks (h=8)

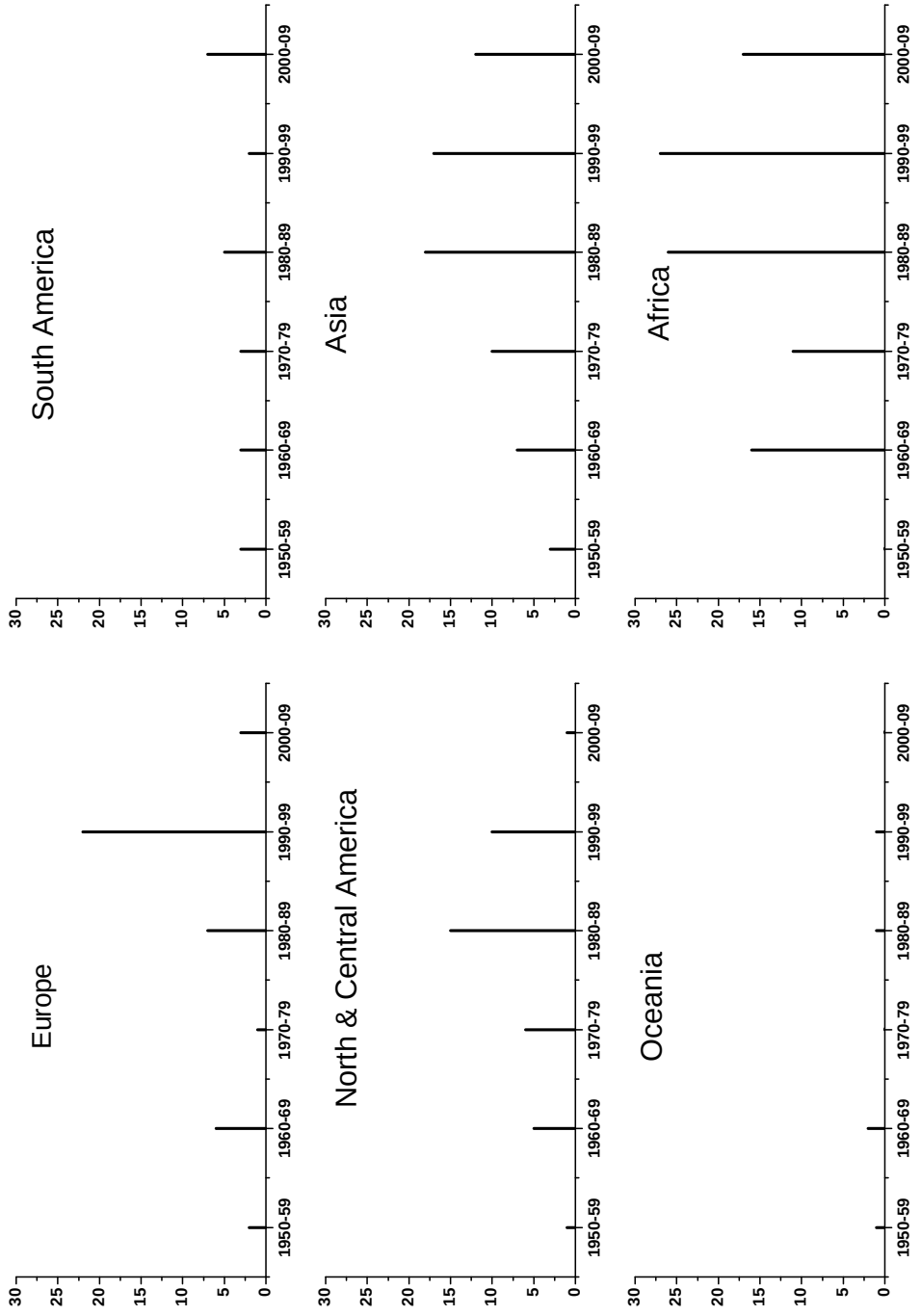


FIGURE 2.8: Decade-wise Regional Negative Breaks (h=8)

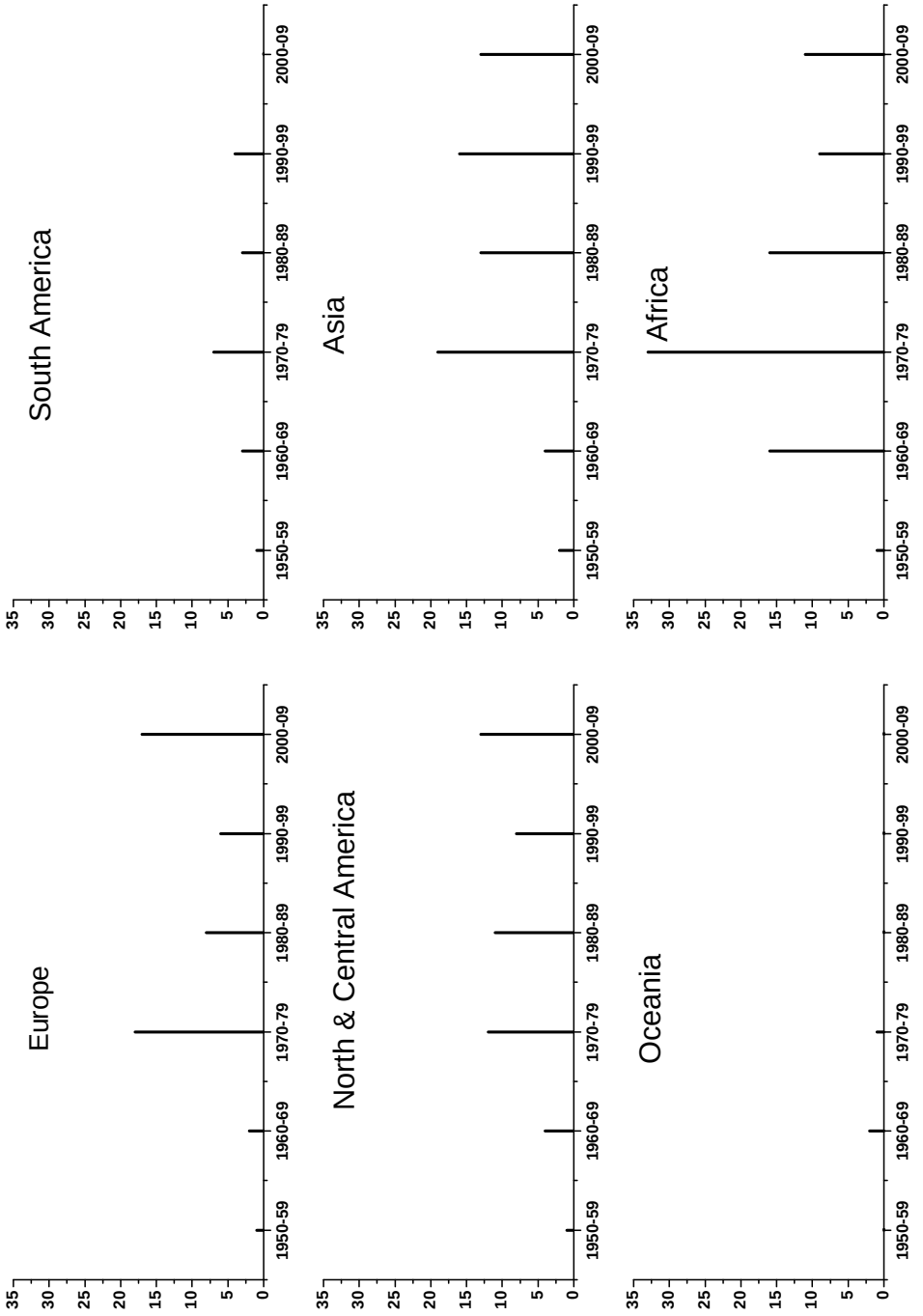


FIGURE 2.9: Quadripartite Indexes: Positive Breaks (h=8)

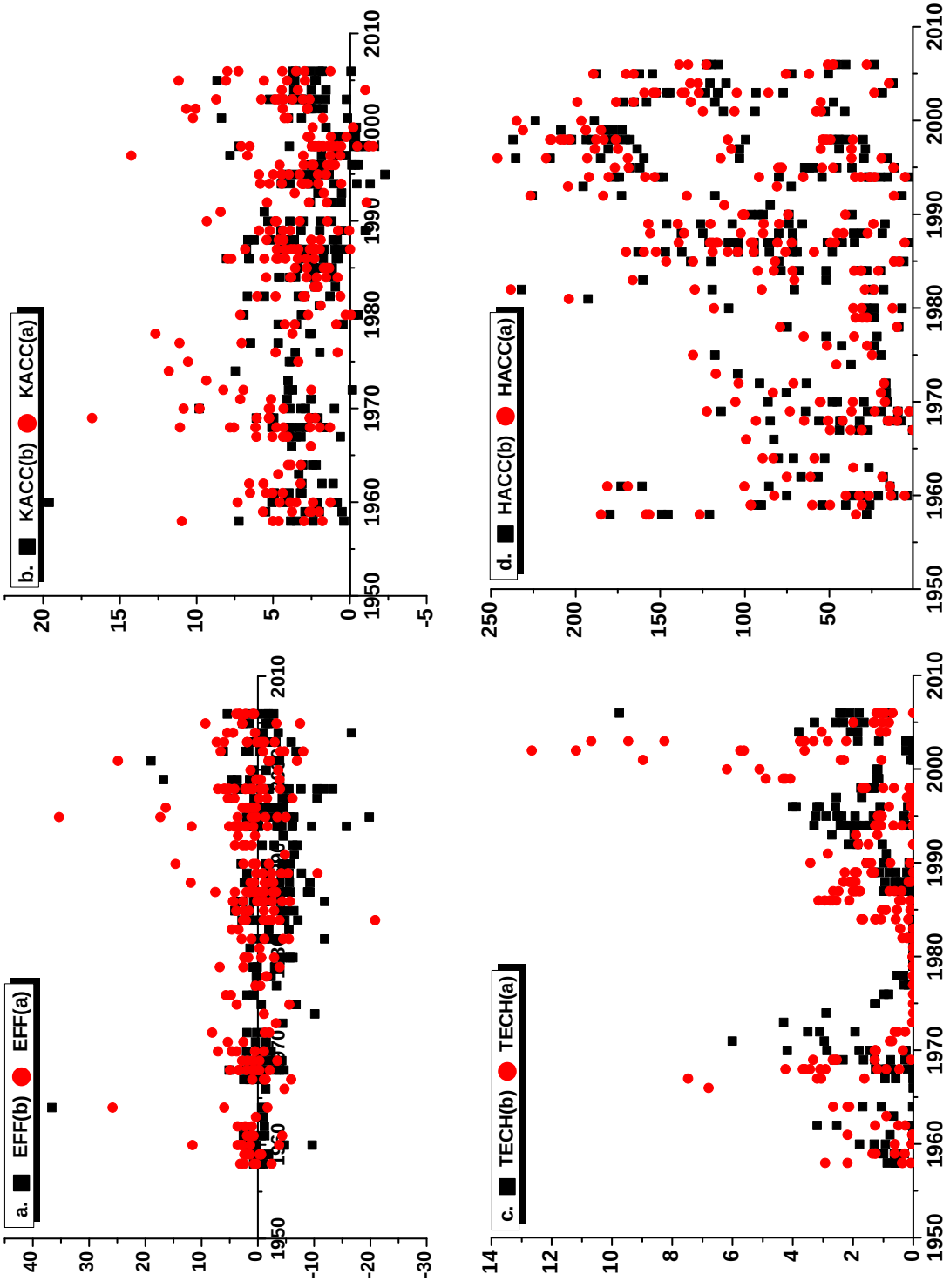


FIGURE 2.10: Quadripartite Indexes: Negative Breaks (h=8)

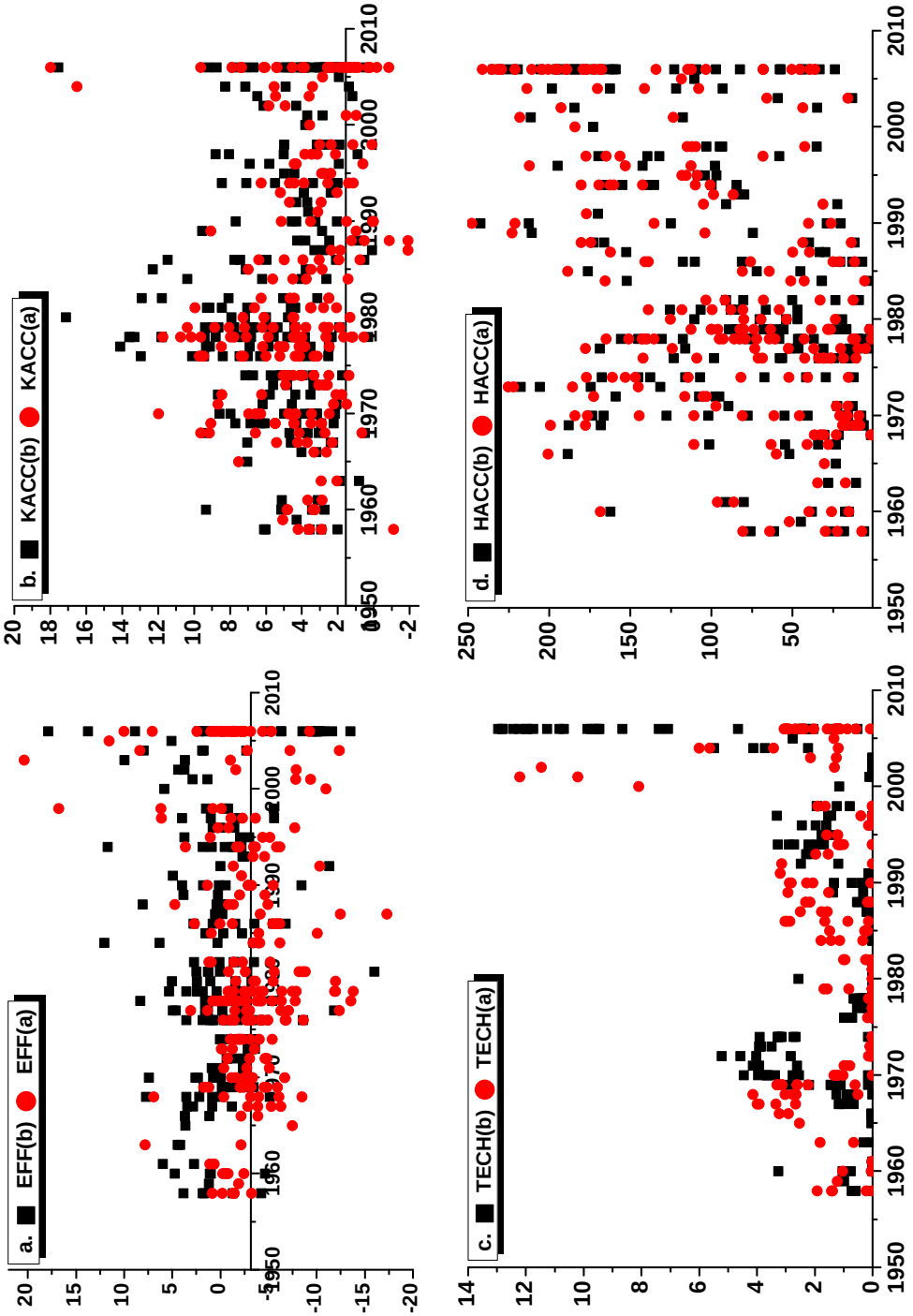


FIGURE 2.11: Decade-wise Regional Quadripartite Decomposition Indexes (positive breaks, h=8)

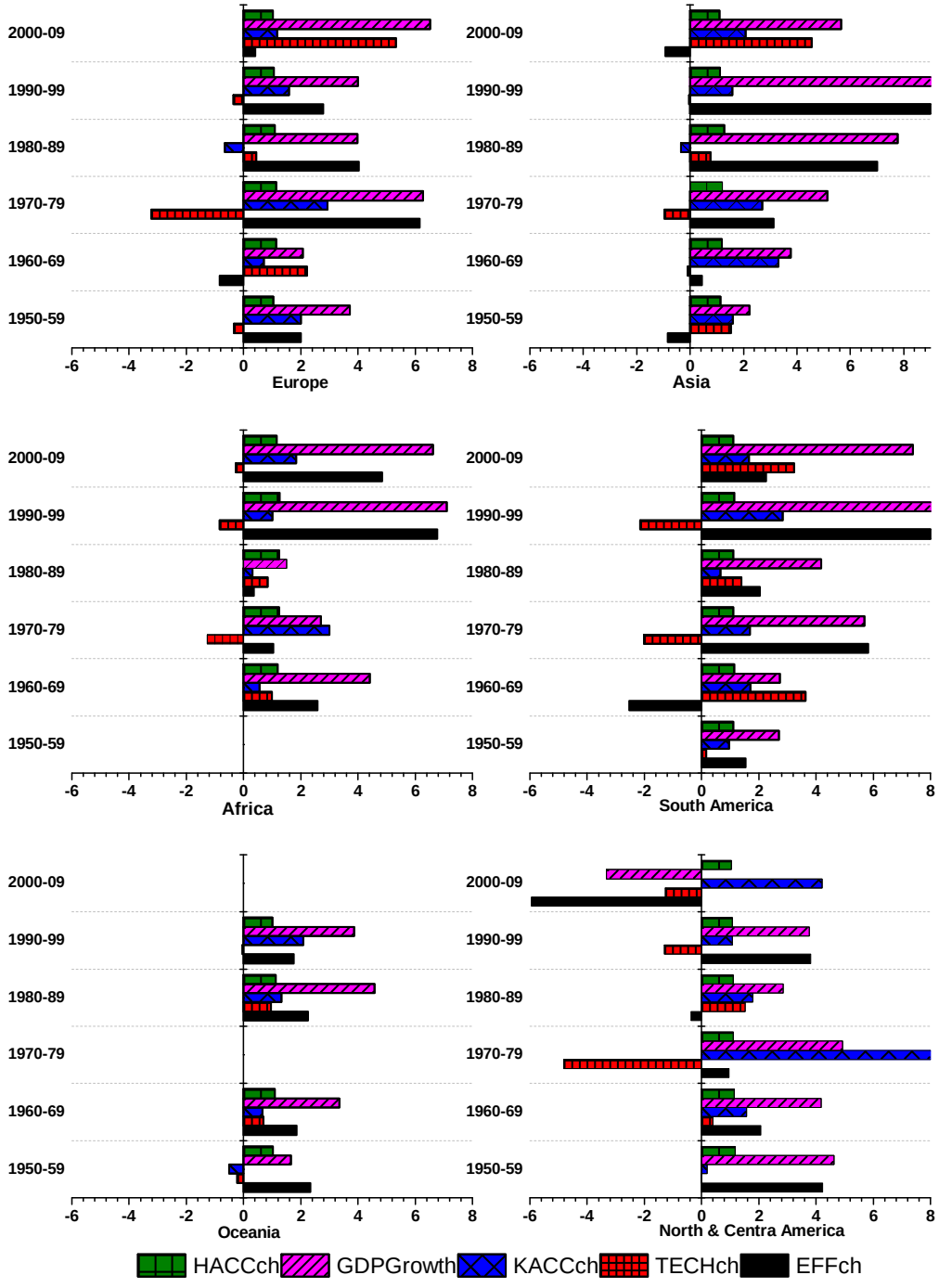
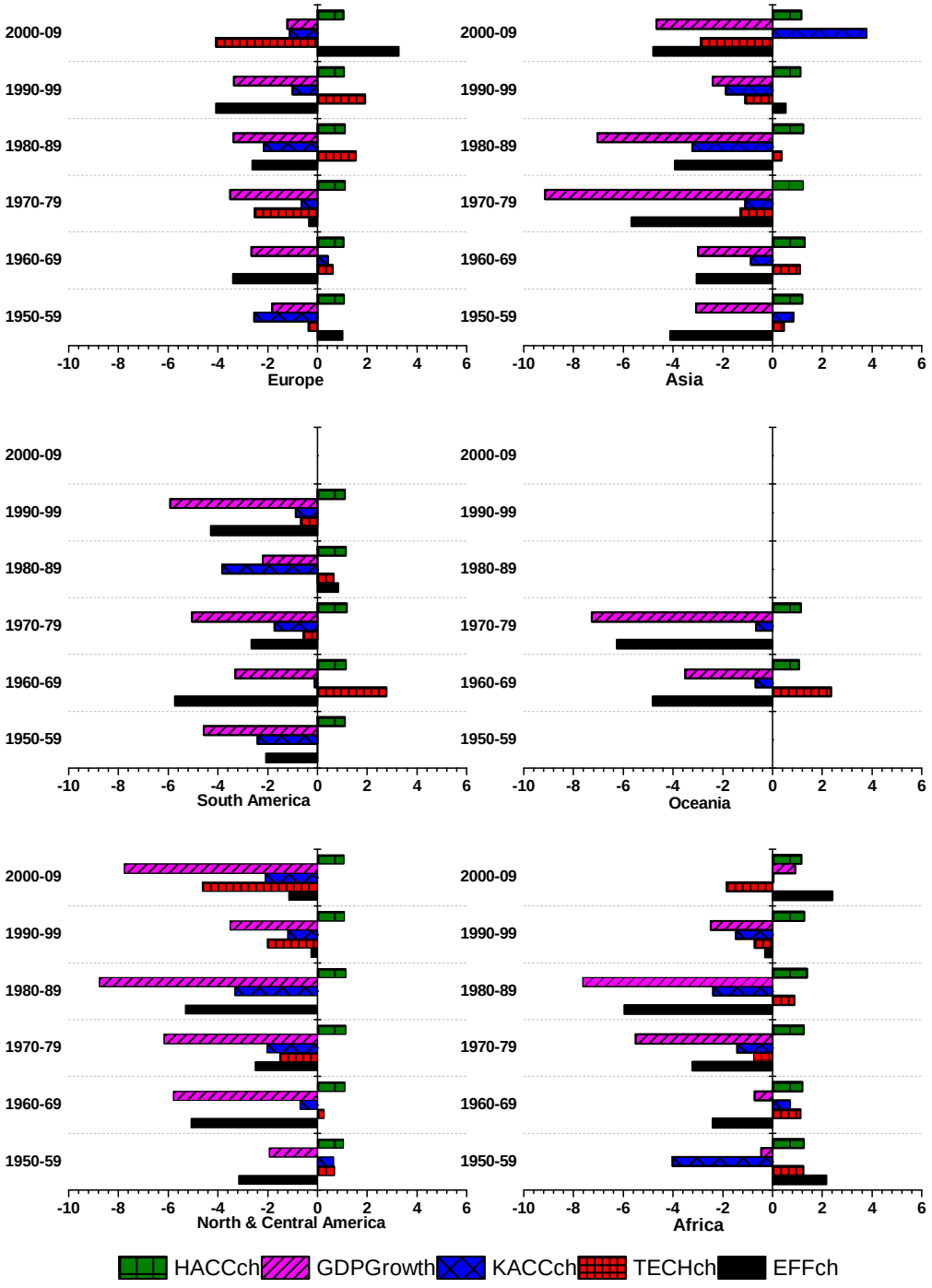


FIGURE 2.12: Decade-wise Regional Quadripartite Decomposition Indexes (negative breaks, h=8)



Chapter 3

Nation's Progress and its Determinants: A Two-Stage Approach

Nation's progress is an essential element in growth theory and it measures the performance of a country which is not exclusively based on economic factors but also on social, environmental and human welfare variables. The aim of this study is to examine the influence of the potential economic, institutional, demographic and geographic determinants on the progress of a nation. The performance of a nation is measured as an estimated efficiency score within which it transforms a given number of endowments such as human and physical capital into national well-being and general human welfare. The economic, environmental and human well-being yardsticks, namely GDP per capita, persons employed, carbon dioxide emission and availability of clean water with proper sanitation facilities are used to measure the nation's progress. The estimated bias adjusted performance scores in stage 1 are regressed on the potential covariates. Simar and Wilson's double bootstrap procedure is used, which allows valid inferences in the presence of an unknown serial correlation in the efficiency scores. The second stage results reveal that the considered covariates play a significant role in the progress of a nation.

3.1 Introduction

There is a long history of economic growth and development analysis of countries and regions and also distribution of the outcomes of economic activity among population. In a neoclassical economic framework, Solow (1956)[206] argued that the growth rate of a region, measured in term of per capita income, is inversaly related to its initial per capita income thus giving positive future perspective for poor regions. Many interesting and important qualitative researches were prompted pertaining to the idea of convergence(see [35]). In general measurement of the performance of a country is becoming fundamental for economic development and policy making whereby the assessment of progress is done mostly in terms of GDP. However, this approach is often strongly criticized as GDP per capita is not able to measure the inequalities in terms of different dimensions of the well-being among nations[65]. Moreover, GDP is only the proxy or partial measure of multi-dimensional population well-being theme, which simultaneously includes both economic and non-economic aspects of societies.

During recent years the analysis of nation's progress and national well-being of different countries and geographical regions is becoming one of the most important areas of interest. Progress can be described as better and improved well-being of people and households and its assessment requires to look into the diverse experiences and living conditions of people along with the functioning of economic system. There is an increased awareness that the macro economic statistics, such as GDP, do not show the clear and enhanced picture of the ordinary people living conditions and experiences. Kuznets (1973)[135] asserted the expansion of the national accounting framework considering both certain costs (such as pollution, urban concentration, commuting, etc.) and positive returns (such as better health, longer life, more comfort and leisure, less income inequalities, etc.). Davidson (2000)[68] in his publication "*You can't eat GNP*" presented the hypothesis that GNP (or GDP per capita) cannot be considered as the only performance indicator of a nation as it does not capture the overall well-being. Moreover, the

economic and financial crisis over the past few years enlightened the policy makers that the economic indicators alone cannot capture the full realm of human costs of the crises.

There are a few new attempts in the literature since 1990s to measure the progress of a nation by using more appropriate variables and indicators. World Bank's human development index (HDI), a composite indicator, based on GDP per capita, the adult literacy rate and life expectancy was introduced describing the individual's access to financial resources, basic educational opportunities and health facilities. However, HDI is criticized because of the high correlation between GDP and the various important background variables and simple weighting of indicators. Hobijn and Franses (2001)[111] highlighted the need to evaluate the nation's progress to encircle the relevant measures living standards. They showed in their study that the convergence in GDP does not imply convergence of the living standards. Moreover, there is a growing interest particularly in the European Union to compare progress and performances of its member countries and to encourage them to find the methods to improve their efficiency and national well-being. The progress of societies and measurement of well-being of people is becoming the key priority for OECD. Over the last 10 years, OECD has been considering the diverse experiences and living standards of people and households beyond focusing on the functioning of economic system. The OECD's *Measuring the Progress of Societies* is headed in this direction. The objective of the conference on *Beyond GDP* in November 2007, hosted by the European Commission, European Parliament, Club of Rome, OECD and WWF, was to clarify the indexes which are most appropriate to measure progress and their integration in the decision making process.

For the measurement of national progress many ways are being suggested, developed and used. These methodologies can be categorized into the following four groups. Firstly, corrected GDP and SNA accounts, such as Sustainable Economic Welfare Index, Green GDPs, Genuine Wealth and the Genuine Progress Indicator

(GPI), where GDP and national accounts are used as the foundation and then the indicators of economic well-being are added or subtracted. However, these measures have limitations as well for instance; the lack of consensus of valuation of the non monetary items and the involved subjectivity. Secondly, the indexes that do not use GDP and measure directly the aspects of well-being. These indexes include Ecological Footprint (EF), Subjective Well-Being (SWB) and Gross National Happiness (GNH), but lack the specifically defined procedure of measurement. Thirdly, the composite indexes, which use both the national accounts or GDP and non-GDP social or environmental indexes, for example, Human Development Index (HDI), Happy Planet Index (HPI). Fourthly, indicator suites in which the well- being variables are reported separately. United Nations (UN) division for Sustainable Development provides a large set of such indicators. Millennium Development Goals and Indicators, National Income Satellite Accounts and Calvert-Henderson Quality of life indicators are some examples in this category[64].

However, there are some restrictions and barriers to the measurement of Nation's progress. The reliable data on the well-being indicators over a period of time is not available or partially missing. There is also a lack of consensus over the importance of the indicators and their selection. Moreover, there is also a global resistance to change the paradigm thinking that GDP growth alone is enough for improvement in human well-being. Due to data limitations these studies are generally limited to the OECD countries. Giles and Feng (2005)[90] analysed 14 OECD countries considering five measures of well-being: the GINI index of income inequality, the rate of poverty, the rate of tertiary education participation, expectancy of life and emissions of carbon dioxide (CO_2). Cracolici et al. (2009)[65] suggested that the selection of the indicators should be based on the characteristics of the countries (developed or developing, low, medium or high income, etc.), and on the capacity of the indicators to capture the relative heterogenity among countries. Hosseini and Kaneko (2011)[112] used 29 institutional, environmental, economic and social variables for 131 countries to derive sustainability indices and attempted to rank the countries on the bases of their Sustainable Development Indexes (SDI).

The innovative economic historians suggested an alternative approach of using the anthropometric indicators, which includes height, weight or rate of mortality[129–131]. Herrmann et al. (2008)[109] tried to rank or categorize countries with their welfare regimes. They distinguished among different kinds of social states. For instance, the new European state model is compared with the Scandinavian model using an index number approach or factor analysis.

In current analysis for measuring nation's progress and well-being the indicators from the three dimensions, namely Economic well-being, Environmental well-being and Human well-being are considered. GDP per capita and the number of persons employed, represent the economic activities. There is an increased recognition over the period of time that for measuring nation's progress quality of environment is of great importance. For environmental well-being Carbon Dioxide (CO_2) emissions (metric tons per capita) is considered. Dasgupta et al. (2006)[67] showed that the argument of famous Kuznets curve (EKC), which predicted that in developing countries pollution increases until a certain level of income, is incorrect. They suggested that even in the overcrowded poor countries the environmental governance is also possible, thereby reducing air pollution. This makes it important to consider the environment well-being in measuring nation's progress. Human well-being is measured by considering the indicators representing basic needs, which are an access of the population to clean water sources and improved sanitation facilities. The approach, used in this work, measures nation's progress by estimating the relationship between the resources that a country possesses (inputs) and its actual achieved level of well-being (output). The main idea is to measure the success of a country by the highest amount of output it has produced using the given inputs.

There is a wide range of literature examining the determinants of the economic performance. These studies, by using different conceptual and methodological frameworks, emphasized various sets of explanatory factors and highlighted the

sources of economic growth. In spite of the lack of unified theory, there are two distinguished mainstream strands, that describe the role of various determinants of economic growth and well-being[25]. First, the neoclassicals (Solow 1956[206]) who highlighted the importance of capital accumulation. Second, is the endogenous growth theory (Romer 1986[187] and 1990[188], Lucas 1988[144]) which drew attention towards human capital and innovation. Another strand, the New Economic Geography (NEG), explained the spatial characteristics of development and economic growth. This approach exerted that economic growth is an unbalance process which favors the already advanced countries (Krugman 1991[133], Fujita et al. 1999[87]. Other theoretical approaches stressed out the important role of non- economic factors in economic performance. Institutional economics emphasized the role of institutions (North 1990[164] and Ménard and Shirley[154]). Importance of socio-cultural factors is highlighted by social economics (Granovetter 1985[94], Knack and Keefer 1995[127]). From political science such as Lipset (1959)[143] and Brunetti (1997)[52] focused on the political determinants. The role of Geographic and Demographic factors are also stressed for the national performance (Gallup et al. 1999[88], Brander and Dowrick 1994[50], Kalemli-Ozcan 2002[120]).

Following the theoretical developments, the empirical researches at first, mostly focused on the economic convergence testing the validity of neoclassical and endogenous growth theory. Later, the studies turned attention towards the determinants of economic performance. With the development of larger and richer databases, for instance, Penn World Tables and better econometric and statistical techniques, such as cross sectional and panel data analysis, the determination of factors of economic well-being and growth is done more precisely and with more accuracy. However, due to varying theoretical frameworks used by the empirical researches, the results and findings differ, and standard conclusions are not fully established. Many studies distinguished between proximate and fundamental sources of growth (Rodrik 2003[184], Snowdon 2004[205] and Acemoglu et al. 2005[3]). The proximate sources of growth refer to capital accumulation, labor

and technology, whereas the fundamental sources include institutions, political systems, socio-cultural variables, demographic and geographic factors.

In this research work, the two stage DEA approach is used to analyze the impact of various economic and non-economic factors on the nation's performance. The national well-being (efficiency scores) is calculated in the first stage using the non-parametric methodology which constructs the efficient frontier with the best performing observations (countries) of the sample. In the second stage, these estimates are regressed against a set of explanatory variables to find their impact on nation's progress. Simar and Wilson (2007, 2011)[197, 202] identified the serious limitations with a two-step DEA approach. They argued that a two-stage procedure does not consider the underlying data generating process (DGP). This casts statistical doubts on the meaning of the estimates produced to explain efficiency. They showed that the statistical inference approaches used in a conventional two-stage DEA procedure are invalid statistically, as the DEA efficiency estimates are serially correlated. They developed a double bootstrap procedure (also used in this work) which gives consistent inferences within the DEA models.

Recent studies in this field investigated the performance of a country and the factors influencing progress by using different conceptual and methodological frameworks and emphasized different set of factors and sources of economic growth. Blum (2012)[49] estimated the government efficiency scores for 62 countries on decade basis between 1850s and 1980s and stated that mono-cultures and redistribution increase efficiency, whereas the effect of the population heterogeneity is negative. Afonso et al. (2010)[7], while examining the public sector efficiency in the new EU member states, concluded that the competence of civil service and high education levels of population as well as the security of property rights seem to facilitate the prevention of inefficiencies in the public sector and provide an "extra boost" to public expenditure efficiency. Hauner (2008)[103] concluded that

higher per capita income, smaller share of federal transfers in substantial government revenue, better governance, smaller government expenditure and stronger democratic control tend to influence the Russian performance. Hauner and Kyobe (2010)[104] examined the impact of spending on government efficiency. They concluded that there is a negative relationship between efficiency and spending. They also presented that the improved institutions, particularly government accountability and corruption control impact the state performance positively. La Porta et al.(1999)[136] empirically investigated the quality of government in a large cross section of countries. They found that the countries which are close to equator, ethno-linguistically diverse, poor, having high proportions of Catholics or Muslims and use the interventionist legal system such as the French or Socialist civil laws exhibit inferior government performance. Moreover, they also stated that the larger governments tend to perform better.

This chapter contributes to the existing literature in following manners. Firstly, the cross-country panel data-set containing 82 countries covering all income levels from 1990 to 2014 is used[1] to measure the national performance. Moreover, nation's progress is measured by using three dimensions of growth namely, economic, environmental and human well-being. Secondly, this study offers methodological improvements by using Simar and Wilson (2007) double bootstrap approach. This helps to produce bias corrected performance score enabling the consistent and reliable estimates of determinants of nation's progress[2]. Thirdly, much broader universe of the regressors, which includes economic, institutional, demographic and geographic variables is used.

The rest of the paper is structured as follows. In section 3.2 theoretical and methodological basis of a two stage bootstrap data envelopment analysis is discussed. Data sources and illustration are presented in section 3.3. In section 3.4

[1]List of the countries given in Appendix B.
[2]The package "rDEA" in R Statistical Software is used.

the estimated results are presented and discussed: the first stage results are based on the computation of the bias adjusted DEA efficiency scores, while the exploration of the potential determinants of nation's progress is performed in the second stage. The conclusions are presented in last section 3.5.

3.2 Methodology

The methodological focus is based on the assessment of the nation's progress scores, where they are not taken in absolute terms but as performance relative to an efficient technology production frontier. The efficient frontier is estimated through DEA which is a very useful tool in efficiency measurement. In particular it helps to overcome the weakness of the regression techniques restricting to only one yardstick. In regression techniques to measure the government efficiency, one output (say life expectancy) is regressed on its determinants (inputs, GDP/c etc.,) and the resulting residuals are interpreted as efficiency. Whereas, DEA allows the researchers to work with the multiple inputs and multiple outputs at the same time.

Non parametric efficiency frontier assumes no particular form and depends on the general reliability properties; such as monotonicity, convexity and homogeneity. Conditional on the data for the observed units (countries here) DEA methodology is based on linear programming algorithm used to estimate the true but not observable production frontier.

DEA models can be specified either from an input or output oriented perspective. In the input oriented model the efficiency scores show the proportion to which inputs have to be reduced to have decision making unit (DMU) on the efficiency frontier. Whereas, in the output oriented model the scores show the proportion by which output has to be increased to reach the frontier. In this work, the output

oriented model under the assumption of variable returns to scale is applied.

The Farrell's definition of efficiency is used. Kneip et al. (1998) [128] described all the assumptions required to derive consistency and convergence speed of the Farrell's estimated efficiency scores with the multiple inputs and multiple outputs (multivariate case). The rate of convergence depends upon the number of inputs and outputs. The higher the number, the slower the convergence rate. Also the convergence of the efficiency scores depends on the degree of the smoothness of the true frontier. Moreover, the efficiency scores are serially correlated in an unknown fashion, therefore standard inference approaches are not appropriate. A naive bootstrap is also inconsistent in case of non-parametric efficiency estimation [128, 199–201]. To successfully deal with the above mentioned problems in a two-stage DEA with covariates, Simar and Wilson (2007)[202] suggested a double bootstrap based on a well described statistical model.

The Data generating process (DGP) needs to be defined in order to study the properties of a DEA estimator. A set of assumptions are formulated by Simar (1996)[196] and Simar and Wilson (1998)[198] to define DGP. Within a two stage DEA, a bootstrap method is described by Simar and Wilson (2007)[202] to achieve bias corrected efficiency estimates and to approximate the asymptotic distribution. For a two stage procedure the DGP in the second stage presented by them is logically consistent with regressing non-parametric DEA efficiency scores on covariates that are different from the inputs used to measure the performance in the first stage. It also accounts for censoring the dependent variable (the estimated efficiency scores) i. e. due to the lumpiness (many values to 1) and is suitable for the two stage method[18]. They also highlighted the separability conditions.

The production process is constrained by the production set:

$$\varphi = \{(x, y) \in R_+^{N+M} | x \text{ can produce } y\}$$

where x represents a vector of N inputs and y a vector of M outputs.

The boundary of φ is the production frontier. The technically efficient units are operating on the production frontier, whereas the technically inefficient units are in the interior of φ . For all $x \in R_+^N$, the required output set is:

$$Y(x) = \{y \in R_+^M | \, (x, y) \in \varphi\}$$

Then for a given $x \in R_+^N$, the $\partial Y(x)$ (the output oriented efficiency boundary) is defined as:

$$\partial Y(x) = \{y | y \in Y(x), \mu y \notin Y(x), \forall \mu > 1\}$$

For a production unit located at $(x, y) \in R_+^{N+M}(x, y)$ the output measure of efficiency is:

$$\mu(x, y) = \max\{\mu | (x, \mu y) \in \varphi\}$$

As in practice the production set φ is unobservable, DEA estimators are used to get the efficiency scores $\mu(x, y)$. For output orientation with variable returns to scale the following linear program is used to get the solution.

$$\hat{\mu}_{VRS}(x, y) = \max\{\mu | \, \mu y_i \leqslant \sum_{i=1}^{n} \gamma_i y_i; x_i \geqslant \sum_{i}^{n} \gamma_i x_i; \sum_{i}^{n} \gamma_i = 1; \gamma_i \geqslant 0, i = 1, ..., n\} \quad (3.1)$$

where $1 \leqslant \hat{\mu}_i$.

Countries are technically efficient when $\hat{\mu}_i = 1$ and are inefficient when $\hat{\mu}_i > 1$. $\hat{\mu}_i - 1$ is the proportional increase in outputs that could be achieved by the i^{th} country with constant held input quantities, γ is a non negative intensity

variable used to scale individual observed activities for constructing piece-wise linear technology [31]. In the second stage, the estimated efficiency scores are employed as the dependent variable $\hat{\mu}_i$, regressing them on potential exogenous (environmental) variables z_i

$$\hat{\mu}_i = z_i\beta + \epsilon_i \tag{3.2}$$

where z_i is the vector of variables assumed to impact the choice and use of y and x, β is a vector of parameters to be estimated and ϵ_i is an independent and identically distributed ($i.i.d.$) continuous random variable which is distributed $N(0, \sigma_\epsilon^2)$ with left truncation at $1 - z_i\beta$, for each i, and assumed to be independent of z_i[3].

Simar and Wilson (2000)[201] observed that $\hat{\mu}_i$ is a downward biased estimator of μ_i, as the countries that determine the frontier in reality may not be included in the sample used, and thus the potential output increase of the country might be greater than the estimated DEA scores[31]. Couple of problems arise, firstly, due to the fact that the true DEA scores are unobserved and the replaced estimated scores $\hat{\mu}_i$ are serially correlated in an unknown way and, secondly, the error term ϵ_i is correlated with z_i since the inputs and outputs can be correlated with the environmental variables[214]. In order to obtain unbiased β coefficients and valid confidence intervals the bootstrap procedure of Simar and Wilson (2007)[202] is used in this work. The package "rDEA" in R Statistical Software is used which implements the Simar and Wilson's (2007) second algorithm for obtaining bias corrected efficiency scores in output oriented DEA model.

The Double Bootstrap

[3]The distribution for ϵ_i is restricted by $\epsilon_i \geqslant (1 - z_i\beta)$ as in the output oriented approach the efficiency scores are larger than or equal to one.

Assuming that the DGP can be simulated by taking the pseudo data set drawn from the original sample generated by the DGP. The DEA efficiency scores are re-estimated using the pseudo data. An empirical distribution of the bootstrap values is obtained by repeating this process number of times. This gives Monte Carlo sampling distribution approximation and facilitates the inference procedures. The performance of bootstrap methodology and statistical inference reliability crucially depend on how well it characterizes the true DGP and on the re-sampling simulation accuracy to copy the DGP[31]. The procedure consists of the following seven steps with two sub-routine loops embedded within:

Step 1. By using equation 3.1, estimate DEA output oriented efficiency scores $\hat{\mu}_i$ for all the countries in the sample data.

Step 2. By employing truncated maximum likelihood, equation 3.2 is estimated and $\hat{\beta}$ and $\hat{\sigma}_\epsilon$ estimates are obtained.

Step 3. The following four steps are repeated L_1 times, for each $i = 1, ..., n$, to yield a set of bootstrap estimates $B_i = \{\hat{\mu}^*_{ib}\}^{L_1}_{b=1}$.

- For each $i = 1, ..., n$, ϵ_i is drawn from the $N(0, \hat{\sigma}_\epsilon)$.

- For each $i = 1, ..., n$, compute $\mu^*_i = z_i\hat{\beta} + \epsilon_i$.

- Construct a pseudo data set (x^*_i, y^*_i) where $x^*_i = x_i$ and $y^*_i = y_i \left(\frac{\hat{\mu}_i}{\mu^*_i}\right)$

- For all $i = 1, ..., n$, using the pseudo data set and equation 3.1, compute pseudo efficiency estimates $\hat{\mu}^*_i$.

Step 4. Compute the bias-corrected estimator $\hat{\hat{\mu}}_i$ as $\hat{\hat{\mu}}_i = \hat{\mu}_i - \text{Bias}(\hat{\mu}_i)$ for each $i = 1, ..., n$, where the bias term is $\left(\frac{1}{L_1}\sum_{b=1}^{L_1} \hat{\mu}^*_{ib}\right) - \hat{\mu}_i$[4].

Step 5. Regress $\hat{\hat{\mu}}_i$ on z_i to yield $\hat{\hat{\beta}}$ and $\hat{\hat{\sigma}}_\epsilon$ employing truncated maximum likelihood.

Step 6. Repeat the following three steps L_2 times yielding a set of bootstrap estimates $\Gamma = \left\{(\hat{\hat{\beta}}^*, \hat{\hat{\sigma}}^*_\epsilon)_b\right\}_{b=1}^{L_2}$

- For each country $i = 1, ..., n$, ϵ_i is drawn from the $N(0, \hat{\hat{\sigma}}_\epsilon)$ distribution.

- For each country $i = 1, ..., n$, compute $\mu_i^{**} = z_i\hat{\hat{\beta}} + \epsilon_i$.

- Regress μ_i^{**} on z_i to yield estimates $\hat{\hat{\beta}}^*$ and $\hat{\hat{\sigma}}^*$ by employing truncated maximum likelihood.

Step 7. Construct the percentile bootstrap confidence intervals for each element of β and σ_ϵ using the bootstrap estimates Γ and the estimates $\hat{\hat{\beta}}$ and $\hat{\hat{\sigma}}_\epsilon$ generated in Step 5. The $(1-\alpha)$ percent confidence interval of the j^{th} element of vector β is constructed as the $Pr(-b_{\frac{\alpha}{2}} \leqslant \hat{\hat{\beta}}^*_j - \hat{\hat{\beta}}_j \leqslant -a_{\frac{\alpha}{2}}) \approx 1-\alpha$ such that the estimated confidence interval is $\left[\hat{\hat{\beta}}_j + a^*_{\frac{\alpha}{2}},\ \hat{\hat{\beta}}_j + b^*_{\frac{\alpha}{2}}\right]$.

[4] See [201]

3.3 Data Illustration

The full data consists of 82 countries covering all income levels. Various sources are used to obtain the basic data covering 1990-2014. Moreover, the sample period is split into 5 non-overlapping periods. Data is collected using the relevant existing literature that informs about the choice of inputs, outputs and a range of economic, institutional, demographic and geographic variables. Besides, this selection is essentially determined by the data availability.

A common concern in such studies is the direction of causation. Mostly in productivity models there is an underlying assumption of straightforward causality from inputs to outputs. However, it is equally possible that there is a simultaneous feedback from outputs to inputs, for instance, in the public sector. There might exists positive correlation between the prosperity of state and its investments, as rich countries are able to invest more. In case of failure to model endogeneity correctly, when using econometric methods, there can be two policy implications. First, the model employed to estimate the production function can be miss-specified. This results in faulty inferences made about the importance of input variables as determinants of those output possibilities which are of a particular interest. Second, incorrect specification of the production function can lead to assessment errors of the managerial efficiency of individual organizations. It is normally assumed that in DEA methodology no material problems are caused by endogeneity[203]. Orme and Smith (1996)[204] introduced the concept of sparsity bias in DEA scores. They found that endogeneity in DEA is problematic, when the number of observations is small and with the increase in sample size its importance reduces. Thus, the problem of causality does not play a role in the current work because of the use of DEA technique with the large number of observations. Moreover, as the current work analyzes the nation's progress at any given point of time or instant and makes no statements about its long run impact or influence on future performance, the problem of direction of causality does not play role.

Stage I: Macroeconomic input and output variables

Every single component of an economy can be classified and aggregated into three categories: land, labor and capital (including physical and human capital)[146]. The efficient use of these resources can make a country successful. The macroeconomic input variables used in the stage one are human capital and capital stock, and data is taken from the Penn World Tables (PWT) 9. In PWT the index of human capital per person is calculated by using average years of schooling in the population (Barro and Lee, 2013[34], Cohen and Leker (2014)[62]) and rate of returns to education based on Mincer equation estimates around the world (Psacharopoulos, 1994[177]). Capital stock at constant national prices (in millions 2011 US Dollar) is constructed as a Törnqvist aggregate of the individual asset growth rates.

Alternative measures of nation's progress and well-being are required as purchasing power based measures do not fully describe the welfare, and the higher GDP per capita values do not mean high performance. Considering only the monetary yardstick can narrow the overall scope of well-being. Neumayer (2003) [163] argued that utility and well-being for people are not merely derived by income alone. Inglehart et al. (2008)[113] described the economic progress as a part of happiness. Several corresponding measures of well-being can be considered such as human development index, standard of living index, happiness index, life expectancy index, dependency ratio, etc. Adult stature, considered to be an excellent indicator in this regard, is also used by many authors[5].

In this work the multidimensional approach to measure national well-being is employed. Both economic and non-economic aspects are considered simultaneously as macroeconomic output variables to assess the country's progress and performance.

[5]See: Komlos (1985, 1987)[129, 130], Komlos and Baten (2004)[131], Steckel (2009)[207] and Blum(2012)[49].

GDP per capita and employment per person are used to measure economic activities. From PWT 9, the output-side real GDP at chained PPPs to compare relative productivity capacity across countries (in millions US Dollars) (RGDPO) divided by population (in millions) is used. Employment (in millions) gives the number of persons engaged. Human well-being is measured by taking the average of the percentage of population that have an access to clean water and improved sanitation facilities divided by 100, and the data is obtained from World Development Indicators (WDI) . Access to an improved water source refers to the number of the population using clean drinking water source. An access to improved sanitation facilities refers to the number of the population using improved sanitation facilities[6]. Furthermore, environmental well-being is measured by the carbon dioxide emissions data (metric tons per capita) and is obtained also from WDI. Carbon dioxide emissions during the fossil fuels burning (consumption of solid, liquid, gas fuels and gas flaring) and during the cement manufacture. [7].

Stage II: Determinants of Nation's Progress

Economic determinants

Sovereignty is one of the basic and necessary requirement of a nation. It includes protection from both internal and external threats. **Defence spending** is the share of the national income kept by the states considering the welfare of their countries. Impact of military spending on nation's performance nowadays is one of the most discussed areas. Arguments related to the impact of military spending on economic growth vary a lot as either it enhances growth or lead to private investment crowding out. Classical school of thought considers military spending as the retarding factor for nation's progress as it reduces domestic savings and private investments due to higher interest rates leading to crowding out, which

[6]Source: WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation.

[7]Source: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States.

means lowering aggregate demand by lowering consumption. However, Keynesian school of thought contends that increased military expenditure stimulates demand, increases purchasing power and national output and thus generates positive externalities[161]. Endogenous growth theory suggests that the impact of state expenditures on long-run economic growth depends upon the size of the government intervention and type of the public spending. Foundation of the relationship between military expenditure and economic growth in the long-run is provided by endogenous growth theory as an inverse hump shaped link[172].

Military expenditure is a special kind of the public spending exerting either neutral or positive impact on some of the industries such as increased investment for the production of defence tools and equipment, more expenditure on research and development activities and employing more military staff. However, in the absence of real threat large military force creates inefficient bureaucracies and it can also exert negative impact by putting extra burden on fiscal resources and increasing the warfare imports for developing countries. Aizenmann and Glick (2006)[14] discussed the positive and beneficial role of military spending for the countries facing serious threats as it ensures their safety. Dunne and Tian (2015)[73] found the negative effect of military burden on economic growth both in short and long-run by using exogenous growth model and dynamic panel data method for 106 countries over the period 1988-2010. Korkmaz (2015)[132] stated the negative impact of military expenditure on economic growth in a study employing panel data analysis for 10 Mediterranean countries from 2005-2010. Yildirim et al. (2016)[216] employed the non-linear panel data to analyze the effect of military spending on economic growth for Middle Eastern countries and Turkey for the period 1988-2012. They highlighted the nonlinear effect along-with asymmetric relationship and suggested that it is state of the economy that actually determines the impact of military expenditure on growth. Military spending data is taken from WDI[8].

[8] Stockholm International Peace Research Institute (SIPRI) , Yearbook: Armaments, Disarmament and International Security. It is based on the NATO definition, which includes all current and capital expenditures on the armed forces, including peacekeeping forces; defense ministries and other government agencies engaged in defense projects; paramilitary forces, if these are judged to be trained and equipped for military operations; and military space activities.

Trade openness is another potential determinant of nation's progress. Through the enhancement of trade, comparative advantage rules and income maximization are gained. In order to grow fast an autarkic, closed or Soviet style models were adapted by many developing countries after their independence but often failed. After opening up to external trade these economies showed faster growth, leading to the stylized fact that "trade causes growth". Openness helps to exploit comparative advantage, transfer of technology, knowledge diffusion, increase in economies of scale and competitiveness[25]. Endogenous growth models highlight that the trade policies effecting the resource allocation increase the worldwide growth rate but simultaneously can adversely affect the country's growth. However, neoclassical school advocates that, due to trade, comparative advantages and efficiency gains increase the growth momentum. Moreover, by resource reallocation according to comparative advantages, a country can get static as well as dynamic advantages. Post Keynesian and Schumpeter evolutionary models present a structure allowing trade openness to effect long-term growth. There are large number of empirical studies confirming the positive relationship between trade and growth such as Sachs and Warner (1995)[191], Krueger and Berg (2003)[43], Babula and Andereson (2008)[20], Bruckner and Lederman (2012)[51]. However, there are many scholars criticizing the robustness of these results on measurement and methodological grounds[208]. Trade openness is measured by adding exports and imports of a year and dividing it by corresponding year GDP for each country. Data is obtained from WDI (Source: World Bank national accounts data, and OECD National Accounts data files).

Gross domestic savings (GDS) is long being considered as an engine of economic growth. Capital is generated by savings leading to technical innovations and progress helping further to reap production economies of scale and specialization. This in turn accelerates the labor productivity which creates positive impact on

GDP. However, by view of standard growth theory the relationship between saving and growth appears to be puzzling[10]. Keynes "paradox of thrift" highlighted the somewhat constrained effect of savings on growth. Aghion et al. (2016)[10] predicted in their model that domestic saving is more important in developing countries to adopt new technologies. In their calibrated and simulated model they found that the quantitative effect of domestic saving on growth is important. Lugauer and Mark (2013)[145] argued that high saving rate of China is the engine of its economic growth. Thornton (2009)[210] showed that higher savings does not mean low consumption, rather it increases capital investment leading to higher economic growth, although the possibility of slowing effect of saving on growth in short-run cannot be excluded. Moreover, this negative effect in the short-run is offset by positive impact of other factors. Domestic savings data is obtained from WDI and is calculated as GDP less final consumption expenditure (total consumption) (Source:World Bank national accounts data, and OECD National Accounts data files).

Barro (2013)[33] believed that **inflation** influences economic growth negatively and, although, in the short-run the adverse impact of inflation on growth is small, in the long-run there are substantial effects on the standard of living. Higher inflation can lead to uncertainty about the profitability of investment projects which causes low investments and, moreover, interferes with country's performance and efficiency. Furthermore, it can effect international competitiveness of a country by making exports expensive. There is a consensus on the inflation -growth relationship in economic theories. Classical economists in there supply side theories emphasize the need to save and invest more in order to grow. Keynesian school provided with the AD-AS framework linked inflation and growth more comprehensively. Monetarists stressed the critical role of monetary growth to determine inflation. Moreover, Neoclassical and Endogenous growth theories highlighted the impact of inflation on capital accumulation and investment leading to growth. The data on inflation is obtained from WDI, where it is measured as consumer price

index (annual percentage) (Source:International Monetary Fund, International Financial Statistics and data files).

Terms of Trade (TOT) measures relative competitiveness of countries and is defined as the ratio of export prices of commodities to import ones. Data is obtained from world development indicators (WDI)[9]. Mostly economic theories tend to believe in the positive relationship between TOT and economic growth. They suggest three channels through which TOT impact economic growth. Firstly, by effecting the capital productivity, which in turn changes the investment size, leading to dynamic impact on economic growth. Secondly, the size of total savings and consumption are altered by TOT changes affecting growth. Thirdly, changes in TOT bring fiscal changes (government revenue and spending) leading to changes in economic growth[157].

Institutional determinants: Institutions play important role in determining nation's progress. Acemoglu et al. (2002, 2005)[2, 3]; Rodrik et al. (2004)[186]; Hall and Jones (1999)[101] empirically examined such factors and their impact on economic progress. Easterly (2001)[76] stressed the importance of trustworthy institutional environment, without which the traditional factors will have no impact on economic performance.

Lipset (1959)[143] studied the impact of political environment on economic growth and performance. In general, the variables used in the political environment by many researchers are durability of political regime (political stability) and degree of democracy. **Durable regime** is the indicator of political stability based on the number of years since last regime transition. Political stability reduces the uncertainty, leading to more investments, and enhanced economic growth. **Degree of democracy** is also an important determinant of nation's progress. However,

[9]Net barter terms of trade index is calculated as the percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000.

the relationship is much more complex as it can either retard or encourage economic growth in many ways depending upon the channel it takes(Arvanitidis et al. (2009)[25]; Alesina et al. (1996)[17]; Barro (1996)[32]). Democracies are often linked with rule of law, secured property rights, economic freedom and human capital which foster economic growth. Democracy tends to secure the property rights, on the other hand, it makes the government vulnerable against the political backlash in case of reforms which are costly in the short run but reap benefits and growth in the long run. Although in democracy there is the possibility to replace inefficient governments, at the same time, influential and more consumption oriented social section of the society demands a greater share of resources. The political leaders in order to stay in power redistribute the income to the various interest groups. This results in higher taxation and lower investments. Polity IV data set is used for the above mentioned two variables, where, the regime durability is measured by the number of years since the most recent regime change and degree of democracy ranges from -10 (high autocracy) to +10 (high democracy) (polity 2 index).

Political competition is measured as the degree of institutionalization or regulation of political competition and the extent of government restrictions on political competition. Polity IV data set is used. Political competition is an important determinant of nation's progress leading to better performing country. Marshfield (2011)[147] found it as the crucial aspect of state development because it provides incentive for the leaders to represent popular will, increases the ability for citizens to challenge the ruling government, and reduces the costs associated with a representative government. But in the developing democracies constructive political competition is difficult to achieve due to social, political and economic exigencies. Such needs and demands create strong incentives for the leadership to quash the opposition. Padovano and Ricciuti (2008) found correlation between the political competition and the short term redistributive policy choices to buy the vote, which in turn suppresses the economic performance[168]. Besley et al. (2010)[45] suggested that lack of political competition may lead to the policies

that "hinder" economic growth. They found, while testing their model on the US states panel data, the robust evidence that lack of political competition in a state is associated with anti-growth policies; lower capital spending, higher taxes and reduced possibility of using right-to-work laws. They also highlighted the strong linkage between low income growth and low political competition. Pavletic (2010), during panel data analysis of 26 transition economies from 1991-2006, confirmed the driving role of political competition in shaping the direction and success of economic reforms in transition countries[171].

Political Rights and Civil Liberties data is taken from Freedom House Organization and are measured on a one-to-seven scale, with one representing the highest degree of Freedom and seven the lowest. Political rights give an opportunity to the people to participate in government activities and contribute in the law making process. These rights presume the government structure allowing the citizens to participate in public affairs either directly or through chosen representatives. Civil liberties include the basic human rights, such as right to live, freedom from torture, fair trial, freedom of thought and religion, freedom of expression, freedom from discrimination, right to liberty, security and privacy. Both variables reduce uncertainty and lead to greater efficiency and better progress.

Social infrastructure constitutes of government policies and institutions creating the economic environment, making individuals to learn productive skills and motivate firms to build-up capital and produce output. It helps to produce favorable and supportive environment leading to skill learning, capital accumulation, invention and technology spill-over. Hall and Jones (1999)[101] defined social infrastructure as the average of an index of government anti-diversion policies and Sachs-Warner index of openness, where the index of government anti diversion policies combines five institutional measures: law and order, bureaucratic quality, corruption, risk of expropriation and government repudiation of contracts[10]. In the

[10]Source: The International Country Risk Guide (ICRG)

current research work the world wide governance indicators (WGI) consisting of six institutional dimensions of governance, such as voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption are used. The openness index provided by Romain Wacziarg and Karen Horn Welch (2008)[212] is used.

Demographic and geographic determinants: In recent years the impact of demography on nation's progress has attracted a lot of scientific attention but still many demographic aspects are left unexplored. Among the examined variables, population density, population composition and urbanization tend to play important role in economic growth and progress. Arvanitidis (2009)[25] suggested the positive linkage between **Population density** and economic growth, because of the enhanced specialization, diffusion of knowledge and so on. The population density is expected to improve the nation's performance by reaping benefits of economies of scale and reducing the costs of service provision. Population composition or age distribution of the population also tends to affect country's performance and growth. The **younger population** (less than 14 years) is considered as the future supply of working force. However, during the transition phase it can exert negative impact on the growth by increasing the dependency burden on the existing workforce, although in long-run the impact can be positive due to the inclusion of fresh and energetic youth into the labor force. According to many economists, the **aging population** (greater than 65 years) also impact the growth negatively through increased ratio of dependents to workers and declining effect on economic productivity. However, some researchers argue that population aging would not negatively impact the productivity, rather effect growth positively due to highly experienced workers over the period of time[176]. **Urbanization** and growth relationship is becoming the important policy concern over the period of time. The big cities are considered to be the engine of economic growth by enhancing the access to infrastructure and social services, better education and health facilities. Big cities create hub for the better international investments, businesses and also attract tourism. Metropolitan cities also provide better non-agricultural

job opportunities, for instance, industrial and banking jobs. Diversity, interaction and cross-cultural collaborations are also reap-able due to urbanization. Although urbanization effect the progress of the country positively, however, its potential to impact growth and progress depends upon the level of infrastructure and conducive institutions[211].

Recent studies showed a positive impact of **Internet** on growth and progress by generating increased and easy access to new ideas, technical and professional knowledge and information enhancing productivity and reduce search costs. However, Moore et al. (2009)[159] pointed out that the internet use impacts growth less positively due to rapid spread in the online crimes. Endogenous growth models focused on the importance of increasing returns, R& D activities, human capital, the generation and spread of new ideas and diffusion of technologies in general for economic growth. Considering this, the new communication technologies such as internet not only reduces the marginal costs of production but also facilitates the generation and spread of new ideas and technological knowledge and enhances research and development[153].This implies an increase in research process, productivity and diffusion of its results and outcomes. Internet usage also impacts the product and labor markets by increasing access to more information and reducing search costs.

The data for the above discussed demographic variables is taken from World Development Indicators (WDI). Population density is measured by using midyear population divided by land area in square kilometers. Population composition consisting of population aging between the ages 0 to 14 and population ages 65 and above are taken as percentage of the total population. Population here is based on the de facto definition of population which counts all residents regardless of legal status or citizenship. Urbanization is calculated by dividing urban population to the total population during a year. Internet users are defined as the individuals who used Internet (from any location) in the last 12 months and

accessed the internet by using all or any type of devices such as computer, mobile phone, personal digital assistant, games machine, digital TV, etc.,.

The **social-cultural factors** such as ethnic composition and fragmentation, language, religion, beliefs, attitudes and socio/ethnic conflicts are being examined in the literature to figure out their impact on national growth and progress. The big part of the theory argues the negative impact of cultural diversity and linguistic fractionalization on social cohesion, quality of governance, economic performance and human development, concluding that diversity has negative influence on national performance. Cultural diversity is regarded as the major handicap within the country's borders[110]. Ethnic diversity and linguistic fractionalization are considered to be the factors responsible for poor economic performance (Easterly and Levine (1997)[74]) and also leading to the societal instability (Nettle et al. (2007)[162]). However, as argued by Arvanitidis et al. (2009)[25] that although cultural diversity may impact the economic growth and performance negatively by creating social uncertainty and unrest, it can create cooperative flourishing pluralistic environment positively effecting the nation's progress in more liberal, tolerant and open societies. While ethnic and linguistic fractionalization impact the performance of a country negatively, **religious fragmentation** tends to impact growth and performance positively as it occurs more often in tolerant and free societies[15]. Fractionalization dataset, compiled by Alberto Alesina and associates, measuring the degree of ethnic, linguistic and religious heterogeneity in various countries, is used.

The role of **geography** on economic growth is long recognized. Researchers such as Hall and Jones (1999)[101]; Easterly and Levine (2003)[77]; Rodrik et al. (2004)[186] used number of variables as a proxy for geography, for instance, latitude, weather, average temperature and rainfall, proportion of land close to coast, soil quality and disease ecology. Empirical studies affirm the direct impact of the geographic variables, such as natural resources, topography, geographical isolation

from global markets, climate and landlocked, on growth and country's performance (See: Armstrong and Read (2004)[24]; Masters and MsMillan (2001)[149]; Bloom and Sachs (1998)[48]; Sachs and Warner (1997)[190]). However, many others, such as Easterly and Levine (2003) and Rodrik et al (2004) after controlling for institutions, found no impact of geography on growth[25]. In the present work following the Hall and Jones (1999) distance from the equator, measured as the absolute value of latitude in degrees divided by 90 to place it on 0 to 1 scale, is used as a proxy for climate. Moreover, following the literature it is expected that the countries, which are closer to equator exhibit low performance.

Tables 3.1 and 3.2 present the calculated summary of descriptive statistics of the variables used in the first and second stage of analysis, respectively.

TABLE 3.1: Summary Statistics of the Variables used in First Stage

Variable	Mean	St. Dev.	Min.	Ist quartile	Median	3rd quartile	Max.
GDP per capita (USD)	16259.51	15671.11	479.16	3840.7	10188.4	27042.6	92207.45
Persons emp. (in Millions)	27.42	93.19	0.17	2.36	5.01	16.55	798.37
Carbon dioxide (Metric tons per capita)	5.35	5.99	0.02	0.90	3.30	8.15	36.93
Average of improved water and sanitation facilities(% of pop. with access)	0.80	0.22	0.21	0.64	0.90	0.99	1.00
Capital stock (USD)	2561167	6190193	6654	103271	578198	1768944	67590072
Human capital	2.43	0.67	1.10	1.94	2.42	2.95	3.73

TABLE 3.2: Summary Statistics of the Variables used in Second Stage

Variable	Mean	St. Dev.	Min.	Ist quartile	Median	3rd quartile	Max.
Military spending	2.36	3.39	0.00	1.23	1.82	2.72	117.39
Openness	0.78	0.53	0.14	0.47	0.64	0.95	4.40
GDS	19.90	14.10	-70.46	13.62	20.43	26.70	61.29
Inflation	18.49	198.93	-9.62	2.21	4.37	8.86	7481.66
TOT	0.02	0.94	-40.47	0.02	0.03	0.05	3.57
Democracy	5.03	6.18	-10.0	2.0	8.0	10.0	10.0
Durable regime	32.93	36.28	0.0	8.0	21.0	46.0	205.0
Political competition	7.41	3.09	-7.0	6.0	9.0	10.0	10.0
Political rights	2.87	1.96	1.0	1.0	2.0	4.0	7.0
Civil liberties	3.03	1.66	1.0	2.0	3.0	4.0	7.0
Social infrastructure	0.42	0.92	-2.07	-0.30	0.17	1.26	2.15
Climate	0.32	0.19	0.00	0.17	0.32	0.46	0.75
Ethnic fractionalization	0.40	0.25	0.00	0.15	0.41	0.63	0.93
Linguistic fractionalization	0.35	0.28	0.00	0.09	0.30	0.60	0.92
Religious fractionalization	0.41	0.25	0.00	0.20	0.38	0.64	0.86
Population density	214.84	691.39	1.40	30.08	80.85	191.67	7736.53
Urbanization	0.59	0.24	0.05	0.43	0.63	0.78	1.00
Pop ≤ 14	29.60	10.49	12.94	19.22	29.14	38.51	49.77
Pop ≥ 65	8.15	5.37	1.47	3.56	5.63	13.16	25.70
Internet Users	19.99	27.00	0.00	0.19	5.06	33.99	96.30

3.4 Results and Discussion

First step DEA Results

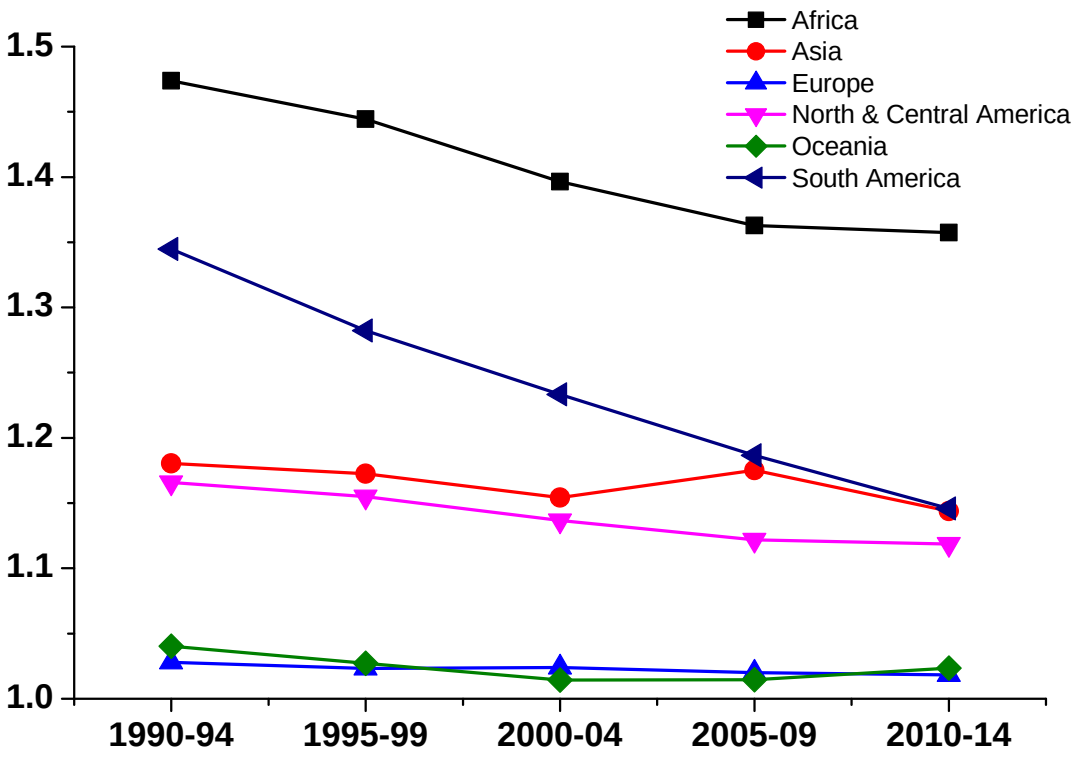
The output oriented (VRS) DEA model is used considering four outputs and two inputs. The input set considered contains capital stock and human capital.The set of output variables includes the GDP per capita, persons employed, carbon dioxide emission and availability of improved water and sanitation facilities to the population. For the estimated performance scores, the value of 1 means nation's progress and bad performance is indicated by the values higher than one.

Fig 3.1 provides the overview of calculated region-wise averaged performance scores for considered 82 countries from 1990 to 2014. In general, the average efficiency scores for European and Oceania countries tend to show the high national performance. The African countries show poor nation's progress in relation to other regions, however, the curve also presents steady but slow improvement in performance for the considered time period. South American countries average scores are declining moderately from 1.35 to 1.15 showing improvement in the regional performance. For Asian and North & Central American[11] countries the performance tends to improve steadily but slowly between 1.1 and 1.2 band.

Fig 3.2 shows the Nation's progress of a few selected Asian countries from 1990-2014. China shows steady and improved performance slightly above one, however, in the year 2014 there is a decline in progress due to deceleration in the economic growth. Indonesia's performance improved moderately between 1990-2004. However, the economy was hit hard due to the natural disaster (Tsunami) in Decemebr 2004 causing high death toll, huge infrastructural damage and lack of funds alongwith the delayed arrival of international aid. The Indonesian economy started to

[11]Including the Caribbean and Central American Countries.

FIGURE 3.1: Region-wise Nation's Progress Averages from 1990 to 2014



recover from this natural catastrophe but still the relative performance is not good. Indian performance is mixed and above one presenting various episodes of growth. The graph shows a hump from 1996 to 2002 marking sect-oral growth slowdown and almost stagnant growth from 2003 and on-wards. The graph for Mongolia shows poor national performance, however, slow but steady improvements towards better progress during the considered time period. Mongolian economy was driven to recession after the collapse of Soviet Union (1991) which was worsened by the series of natural disasters during 1996. However, the situation of export based Mongolian economy improved due to international funding and increased mining after 1999. The nation's progress graph of Nepal shows bumps and peeks at various points. Nepal is a landlocked and among one of the least developed countries of the world. The economy started to progress with the restoration of

democracy from autocratic rule in 1991. However, from 1996 the Maoists armed struggle damaged the societal fabric for more than a decade . By the year 2006 the democracy won over the tri-partite power struggle, the King, the main stream political parties and the Maoists, leading to liberal economic stance[166]. The performance graph of Pakistan is relatively smooth but above one showing low national progress.

FIGURE 3.2: Nation Progress in Asian Countries from 1990 to 2014 (selection)

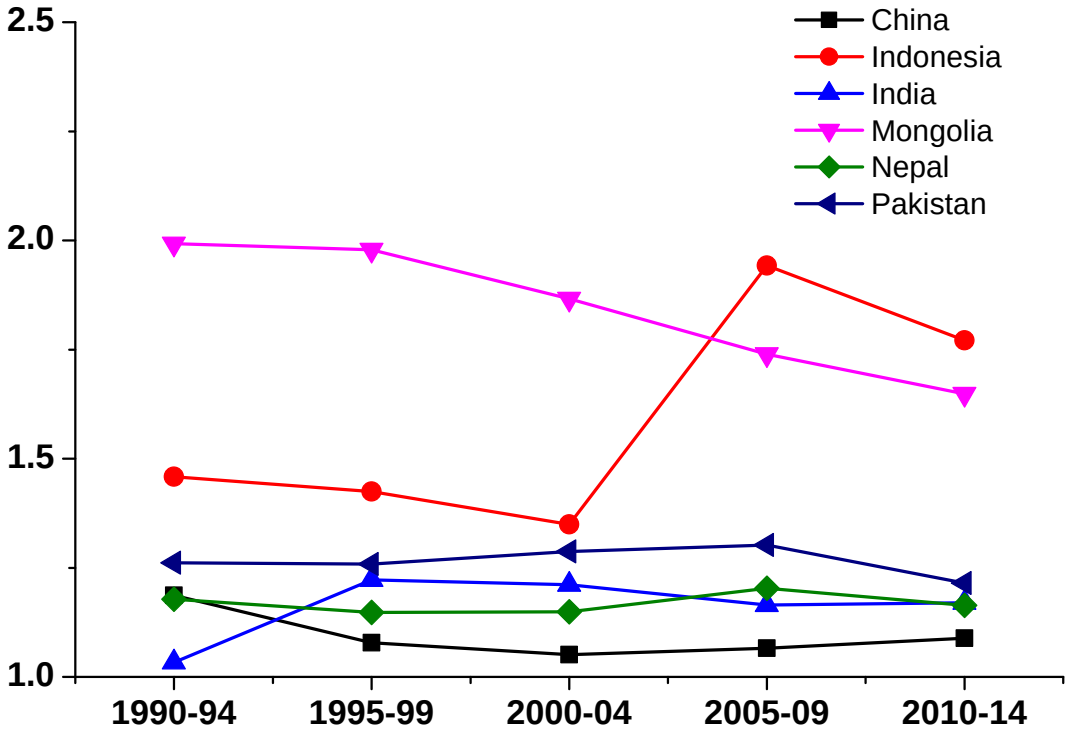


Fig 3.3 shows the performance scores for the selected African countries. The performance scores for Kenya show increase in poor progress over the considered period of time. Kenya's economic performance slowed down after 1997 due to political instability, corruption and high population growth. The performance graph of Mali is non smooth with relatively poorer performance in 2000. Mali's economy

over the last decade is generally viewed as performing well, however, the rate of economic growth is slow due to over dependence on a few key sectors, persistent structural weakness, lack of economic opportunities and increased unemployment. Mozambique performance is relatively smooth and closer to 1 after 1996, because of political stability and donor assistance. The performance curve for Mauritania show poor progress during the first decade, which started to improve and accelerate after 2000, because of the rescheduling or cancellation of the foreign debts. Swaziland performance scores are improving steeply from 1990 to 2005, largely because of the liberal policies concerning foreign and private investments in areas, such as mining and industry. But due to the deteriorating investment climate, erosion of trade preferences, lack of competition, poor institutions and HIV/aids affected bad workforce lead to decline in growth. The performance curve for Uganda shows negative trend after 2002 caused by increased debt burden to finance government spending, poor bureaucracy, high corruption and strict business policies leading to reduced private investments.

The national progress of the South American countries is shown in figure 3.4. Overall the trend among the South American countries is towards better performance. Argentina, Chile and Uruguay are showing progress, almost approaching one, during the considered period of time. Bolivia can be considered as the one of bad performing country relative to other South American countries, however, it is still positive progress at moderate rate. The Brazil performance curve shows a small hump during 2000 due to political confidence crises during the general elections; afterwards the progress tends to be improving. The Colombian progress tends to be steady-going over the considered period of time. For Ecuador and Peru the progress pattern is moderate and positively moving towards the better performance scores. The performance scores of Paraguay show sharp increase in performance due to its sound and predictable macroeconomic policies, solid financial system and poverty reduction.

FIGURE 3.3: Nation Progress in African Countries from 1990 to 2014 (selection)

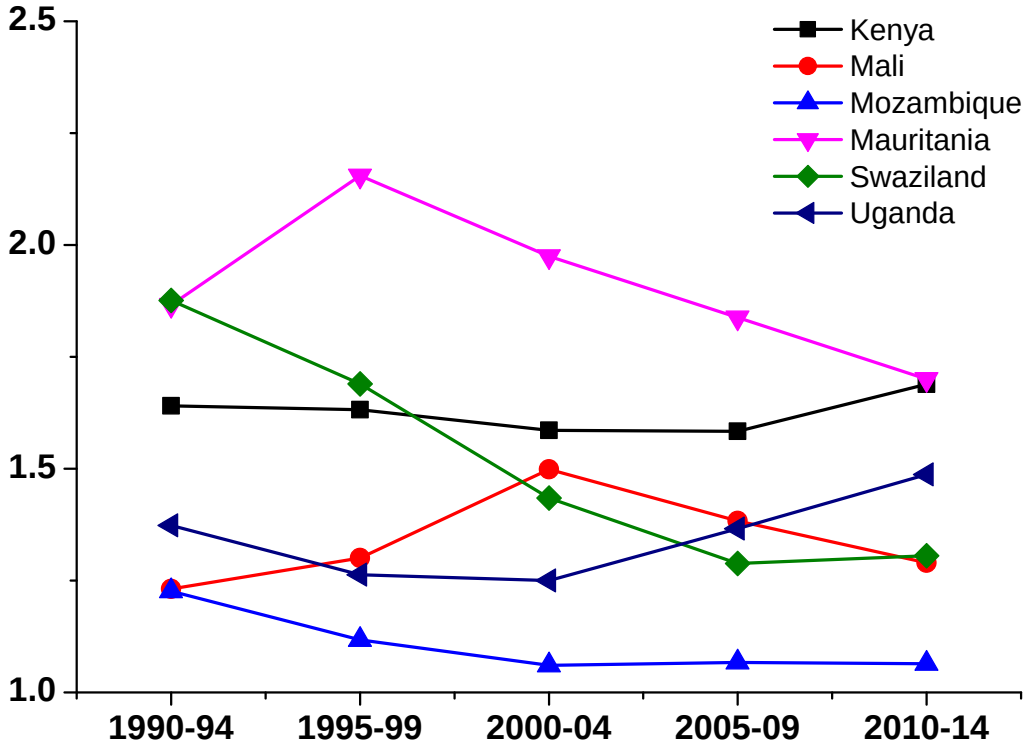
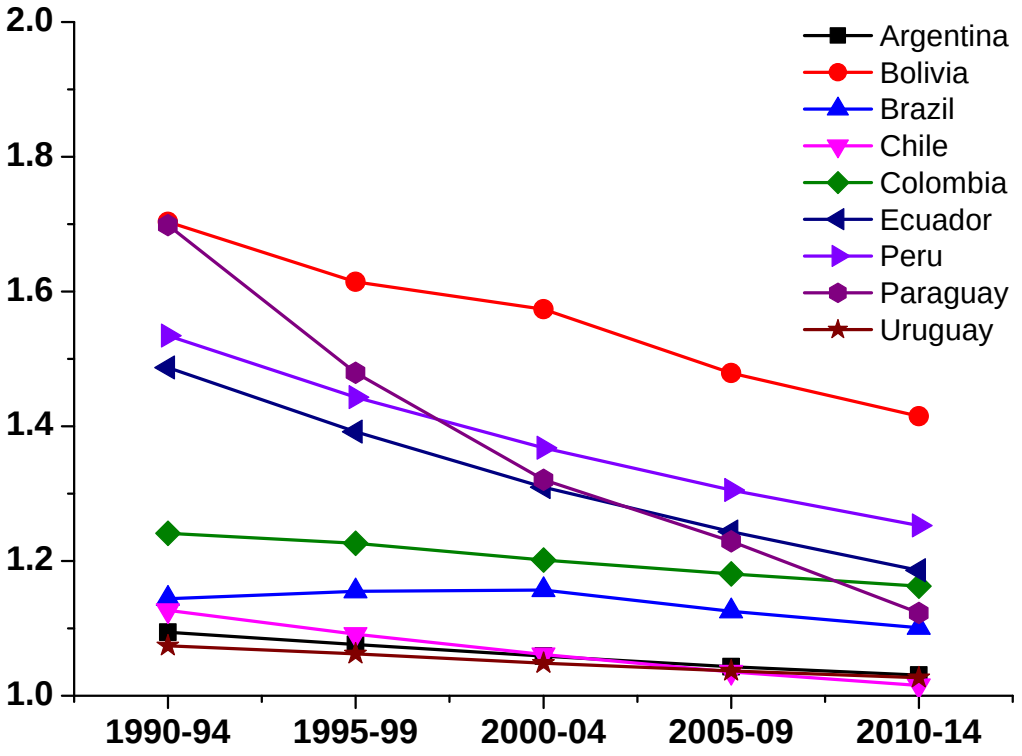


Fig 3.5 gives the progress pattern of a few North and Central American countries. Canada performance scores are close to one showing real good national progress and growth considering all dimensions of welfare which are economic, environmental and human well-being. USA performance scores are also near one except a few downturns such as during 2007, because of the Great Recession officially lasted from December 2007 to June 2009. The progress graph for Guatemala shows almost stagnant progress during the first decade from 1990-2000 followed by the better performance during 2000-2005. However, due to decline in growth rate and increased regional poverty the performance declined. The performance of Jamaica tends to be steady and almost stagnant over the considered period of time. The performance curve of Mexico shows sharp improvements in progress due to unprecedented stable macro economy leading to reduction in inflation and interest

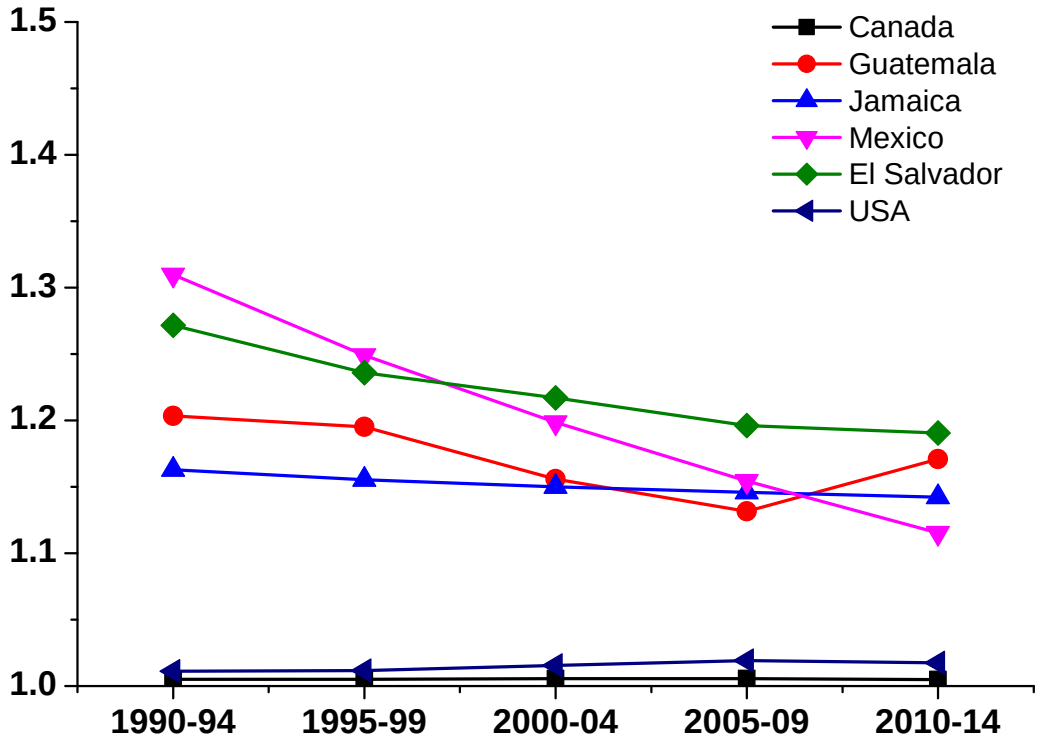
FIGURE 3.4: Nation Progress in South American Countries from 1990 to 2014 (selection)



rates and increased per capita income. El Salvador progress is slow but steadily improving over the considered time period showing recovery trends after the end of civil war in 1992.

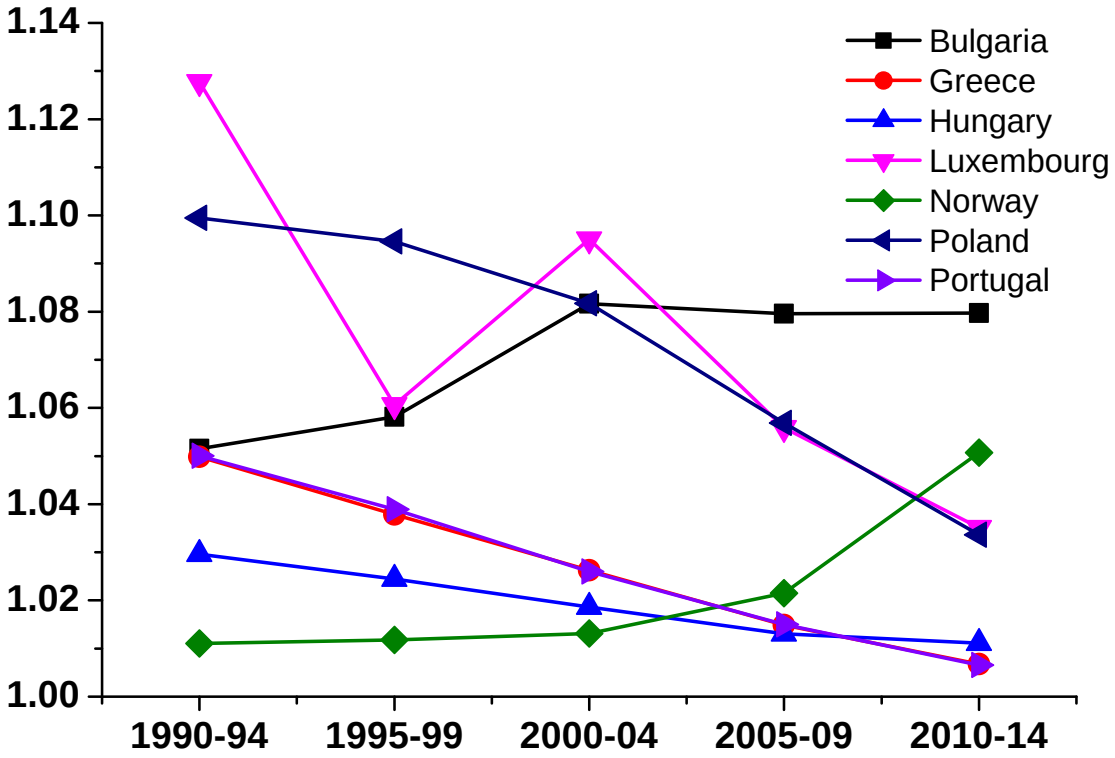
Figure 3.6 presents the national performance of the selected European countries. Bulgarian economy showed better performance during 1992-1995, which after 1995 turned bad and from 2000 become almost stagnant. Bulgaria is situated in the Eastern Balkans and is going through the transition phase to become market economy after the end of the Communist rule. The graphs for both Greece and Portugal show the moderate and consistent improvement in national performance and approaching 1. The nation's progress curve for Hungary also shows positive

FIGURE 3.5: Nation Progress in North & Central American Countries from 1990 to 2014 (selection)



improvements, although at relatively slow pace (relatively flat). The graph for Luxembourg shows high peek of bad performance during 1998-2003 attributed to the financial sector weaknesses, which in turn effected the economic growth and public finances. Norway graph shows relatively consistent and better performance. However, after 2010 the performance tend to decline due to the weak global economic situation effecting the demand side components such as public purchases of goods and services, business sector investments and exports, which creates dampening impact on the Norwegian economic growth. The Poland performance curve tends to show relatively steep progress (although above 1) after 2000 following the policy of economic liberalization during 1990's.

FIGURE 3.6: Nation Progress in European Countries from 1990 to 2014 (selection)



Second step- Determinants of Nation's Progress

At this stage, the bias adjusted performance scores are related to potential determinants. The results for VRS double bootstrap DEA specifications are presented in Table 3.3, where eight alternative models are presented, depending on the considered environmental variables. The 100 bootstrap replications are used to compute bias corrected efficiency estimates $\hat{\hat{\mu}}_i$. The estimates of confidence intervals are constructed by using 2000 replications[202].

Based on the output DEA formulation in section 3.2, *ceteris paribus*, a negative

sign of the estimated regression parameter indicates lower inefficiency (positive influence on progress), while a positive sign on an explanatory variable shows higher inefficiency (an obstacle to progress)[12]. In table 3.3 bias adjusted coefficients are presented and the statistical significance of the examined coefficient is indicated when the value of zero does not fall within the associated confidence interval.

Economic determinants

The increased **military expenditures (ME)** tend to effect the nation's progress positively. As defence expenditure is a special kind of spending being carried out to preserve sovereignty of a country, it exerts positive influence on national performance. In relevant literature the impact of defence spending on nation's progress is mixed. Aizenmann and Glick (2006)[14] argued, that the increased expenditure on the military is beneficial to the economic growth for the countries in acute threats, as this ensures safety. However, as shown by Gupta et al. (2001)[99], increased military expenditure is a loss on the part of welfare and human well-being. The large military forces lead to large military order volumes, inefficient bureaucracies and organizational set-ups, that lead to rent seeking and corruption[97]. Lee and Chen (2007)[137] applied long- run panel regression analysis on the data for 27 OECD and 62 non-OECD countries from 1988 to 2003 and found the positive relationship between GDP and ME for OECD countries and negative impact on the non-OECD countries. For low income countries Chang et al. (2011)[60] applied GMM method to 90 countries panel data from 1992 to 2006 and found negative impact of ME on economic growth. Wijeweera and Webb (2011)[213] applied panel- co-integration from 1988-2007 for five South Asian countries[13] and found positive but negligible impact of ME on economic growth.

[12] See Simar and Wilson (2007)[202].
[13] Bangladesh,India, Nepal, Pakistan and Srilanka

The impact of **Tade openness** was expected to be positive on the nation's progress. However, results show negative and significant impact of trade openness on Nation's progress. Bhalla (2012)[47] pointed out, that in order to improve the significance of openness the currency valuation measures should be introduced. The open economy along-with competitive currency tend to impact growth and progress positively.

Gross domestic savings effect the nation's progress positively. Savings help to generate capital leading to technical innovations and progress helping further to reap production economies of scale and specialization. This in turn accelerates the labor productivity, thus creating positive impact on economic growth and nation's progress.

Institutional determinants

The **degree of democracy** impact nation's progress negatively, with weak confirmation in model 8 at 1% level of significance. The result does not imply that autocracy is better than democracy. Although the Democracy ranges from -10 (high autocracy) to +10 (high democracy), but about 75% of the data gives positive democracy values suggesting a relative disadvantage of the liberal democracy over the restricted one. Barro (1996)[32] found the slightly negative effect of overall democracy on growth in an analysis on a panel of 100 countries while controlling the factors, such as initial level of GDP per capita, government consumption, free markets, property rights and human capital. The democratic governments display status-quo bias, submit more to interest groups and avoid costly reforms[16, 83]. Tavares and Wacziarg (2001)[209] stated that democracy fosters growth by improving human capital accumulation and, less robustly, by lowering income inequalities. However, they also pointed out that democracy hinders growth by reducing the

physical capital accumulation rate and by increasing the ratio of government consumption to GDP.

Significant and positive coefficient of **durable regime** implies that political stability and reliable political rule leads to consistent budgetary planning and enhances nation's performance by reducing uncertainty and encouraging investments.

The model 5 in Table 3.3 gives the positive and significant impact of the **political competition** on nation's progress. The political competition at elections does effect the performance positively depending upon country's overall factors of development. However, the lack of political competition and political market imperfections can lead to the low credibility of pre-electoral manifestos and voting lists. The positive impact of political competition is channeled through many ways to nation's progress. It adds to the society's pool of knowledge and suggests alternative policies to overcome agency and capacity problems of a country. Political competition also influences the behavior of the political leaders, representatives and politicians to act in the best interest of people in order to avoid the dismissal and stay in the power. The citizens of a politically competitive society can express, organize and assert their demands in an efficient and convincing way.

Political rights can be defined as the degree to which government is controlled by the individual. The impact of political rights on the country's performance is positive suggesting that more the citizens have political freedom, the better they can influence the political setup either themselves or by their representatives. Moreover, because of more checks and balances political liberties help to take better and more sensible decisions leading towards positive growth and progress.

Socail infrastructure effects the performance of a country positively. Social

infrastructure not only directly influence the growth and progress, but also indirectly effects the other determinants of economic growth, such as investment, human and physical capital, technical improvements, innovations and skill acquisitions. Social infrastructure builds favorable and constructive environment in a country that supports productive activities, technological development and capital accumulation.

Demographic and geographic determinants

The **climate**, proxy here by the distance from the equator, shows a positive impact on the country's performance. The countries closer to the equator are at natural disadvantage because of the high temperature and bad soil leading to low productivity and, thereby, lower growth. Moreover, the tropical climate is more pron to diseases and epidemics and due to high temperatures less conducive to work, thus slowing down the pace of growth. The result is in accordance with the findings of La Porta et al. (1999) [136] that the countries which are farther from the equator exhibit good performance.

Ethnic and linguistic fractionalization have negative and significant effect on nation's progress. The results confirm the theoretical and empirical survey that the cultural diversity and ethno-linguistic factionalization negatively impact the social cohesion and governance quality, economic performance and human development, suggesting that diversity is not good for nation's progress. Due to cultural diversity and more spoken languages the problem of integration arise. Moreover, the communication becomes more difficult and it gets expensive to deliver the public services. The transaction costs to overcome many languages and ethnic prejudices increase. Linguistic differences may also require increased redistribution policies which are potentially less efficient[16, 74]. The results are in line with the findings of La Porta et al. (1999)[136] that the national performance is reduced due

to higher ethnic and linguistic fractionalization. However, **religious fragmentation** positively effect the national performance showing that in tolerant, secular and free societies more religious sects live together and contribute positively in growth and progress.

The demographic variables considered have positive and significant impact on growth and progress of a nation except population aging under 14 having mostly positive but insignificant effect. Hauner and Kyobe (2010)[104] evidenced the positive effect of higher population density on government efficiency by decreasing the cost of service provision because of the economies of scale and by reducing transportation and heating costs. **Population density** helps to increase the knowledge diffusion, reap benefits of economies of scale and reduce overall costs. **Urban population growth** tends to increase the living standards and promote the growth. Moreover, urbanization along-with conducive environment, supportive policies, suitable infrastructure, and institutional setup can lead to better performing and progressing country. **Population above 65** also positively effect the progress of a nation by rendering their experiences and skills to the working force of a country. Moreover, with better health facilities over the period of time the working age has increased and reduced population dependency allowing more learned and experienced workers to stay longer in the labor force.

The impact of the **internet use** is positive and significant for the nation's progress. The increased internet accessibility helps to ease the transfer of knowledge and skills and enhances the access to the latest research and development (R& D) from all over the world. Over the period of time, the R& D process and the spread of resulting knowledge is changing tremendously because of the use of new communication technologies. Thus internet use induces not only temporary growth but also permanent growth.

3.5 Conclusions

The current study undertakes the examination of determinants of nation's progress with a cross country panel data of 82 countries from 1990 to 2014. The nation's progress is measured using three dimensions of well-being, that is economic, environmental and human well-being. The economic well- being is measured by using GDP per capita and the number of persons employed. Over the period of time the role of healthy environment, use of energy resources and natural resources, including better air quality (important for both nature and human), green house gas emissions, energy consumption, renewable energy resources, renewable water resources, forests and biodiversity, respectively, are considered to be of great importance for measuring well-being of a country. Carbon dioxide emissions are taken as a proxy for measuring environmental well-being of a country. Moreover, human well-being is measured as the population having access to the clean water and safe sanitation facilities, representing the basic needs of human welfare. This study also offers methodological improvements compared to the existing relevant literature as the biasd DEA efficiency scores, which provide unreliable standard errors when used in the second stage as dependent variable, are replaced by the bias adjusted efficiency estimates. For this purpose the methodology proposed by Simar and Wilson (2007)[202] is used. Moreover, the present study is able to draw more realistic picture of the considered countries progress as more practical input and output variables including three dimensions of well-being are used to measure the Nation's progress, comparing to many other studies which rely only on GDP for estimations.

This work tries to investigate and explore nation's progress by considering economic and non-economic aspects simultaneously. The results give insight into the average behavior and performance of countries over the considered period of time. The African countries in general experienced a decline in progress due to political instabilities, poverty, natural disasters such as famine and droughts, influence of war and larger dependency on foreign aid and donations. Overall, the progress

of Asian, European, South American and North & Central American countries is relatively mixed, however, showing moderate improvements during the considered period of time.

The regression results show that among the economic determinants the impact of military spending is positive, as increased spending not only help to secure the sovereignty of a country, it also leads to increased investments in R& D. The role of openness tends to be negative on nation' progress, in the absence of competitive currency valuation measures. Gross domestic saving role is also positive, as it helps to reduce the foreign dependence of a country by generating and using the domestic funds to create capital. Results also (weakly) present that restrictive democracy tends to be advantageous as compared to the liberal democracy. The institutional environment of a country exert not only the direct influence on the growth and progress but also effect the human and physical capital accumulation, investments, technical changes and processes of economic growth. The stable and trustworthy institutional setup ensures better progress and by increasing the level of accountability of institutions and controlling corruption the higher welfare levels can be achieved. Culturally diversified and ehtno-linguistic heterogeneous societies are less efficient and are more pron to corruption. The effect of demographic and geographic factors is also positive. The internet use also effects the progress positively, as it helps to accrue more knowledge and latest technical and research skills without incurring the mobility costs.

The results presented in the current work suggest many further framework scenarios, which can be used to increase the nation's progress and enhance the welfare and well-being of a country. After the financial system crises, partly caused by the amplified stress on material growth at all costs, it is realized that actual and balanced growth and development is being neglected. The requirement now is to set new goals and establish new ways to estimate progress. The new goals

should consider social, ecological welfare along-with sustainable economic well-being. Moreover, proper measures and strategies should be adapted to achieve those goals. Policy makers should focus on plans and strategies to better allocate the resources and funds. Conducive environment and suitable institutional set-up helps to strengthen performance of a nation. Furthermore, trustworthy institutional environment along-with suitable economic policies helps to reap more benefits from demographic and geographic factors, which otherwise either need a lot of time and effort to change (population composition) or cannot be altered (geography). The impact of the linguistic fractionalization and ethnic differences can be reduced by redistributing the funds to all sections of the population and by providing all with the equal access to education and other social benefits.

Table 3.3: The Determinants of Nation's Progress

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Military expenditure	-0.1212***	-0.1080***	-0.1055***	-0.0670***	-0.1363***	-0.1080***	-0.1146***	
Openness	0.0893	0.4341***	0.0880		0.3026***	0.2422***		0.1292*
GDS	-0.0054***	-0.0085***	-0.0032	-0.0053**	-0.0126***	0.0024		
Inflation	0.0001	0.0002		0.0001	-0.0001			
TOT	0.0275	-0.0113		0.0392	-0.0382			
Democracy	0.0069					0.0139	-0.0080	0.0098*
Durable regime	-0.0031		-0.0025	-0.0094***	-0.0179***			-0.0061***
Political competition					-0.0719***	-0.0246		
Political rights			-0.0516***				-0.0626***	
Civil liberties				0.0104				
Social infrastructure		-0.5850***				-0.4094***		
Climate		-1.3432***			-2.6405***			0.3776
Ethnic fractionalization				0.9621***			0.3476***	
Linguistic fractionalization		0.4771***						
Religious fractionalization					-0.3304**	0.0561		-0.0957
Population density		-0.0020***			-0.0026***	-0.0021***		
Urbanization	-0.1642		-0.0569	-0.5818***		-0.8268***		
Population ≤ 14			-0.0029				-0.0033	0.0077
Population ≥ 65	-0.3107***		-0.2864***				-0.2264***	-0.2311***
Internet users			-0.0199***	-0.0527***		-0.0429***	-0.0221***	-0.0256***

The positive coefficients express negative influence of the independent variable on Nation's Progress. * Value of zero does not fall within 90% Confidence Interval. ** Value of zero does not fall within 95 % Confidence Interval. *** Value of zero does not fall within 99% Confidence Interval. Estimated using R Statistical Software. Time dummies are included.

Chapter 4

Impact of Financial Development and Remittances on Economic Growth and Productivity Growth

A panel of 103 countries including developed and developing economies over the period 1980-2014 is used to study the role of financial development, remittances and their interaction terms on economic growth and total productivity. A panel econometric framework is used and the findings of the study are following: 1. The role of financial development and remittances is positive on economic growth and their interaction terms support the substitution hypothesis, suggesting the relaxing role of remittances in case of weak financial markets in receiving countries. 2. However, the role of financial development and remittances on productivity growth is insignificant. 3. The state of development of the countries also influences the corresponding roles of remittances, financial development and their interaction terms on economic growth.

4.1 Introduction

In an influential theoretical and empirical survey Levine (2005)[138] suggested the role of financial development to improve economic growth in the long run. This survey also pointed out the reluctance of many economists to acknowledge the importance of finance in economic growth. The collection of essays by the pioneers of development economics, featured no role of financial markets and institutions on economic growth[152]. The whole idea of the finance-growth nexus was dismissed by Lucas (1988)[144]. He considered the finance as an over-stressed economic growth determinant. Robinson (1952)[182] believed that finance acts in response of the real sector, rather than the view that finance induces economic growth. Merton Miller (1998)[156] argued that the proposition regarding the contribution of financial markets to economic growth is "too obvious for serious discussion".

However, some other influential economists such as Bagehot (1873)[27], Schumpeter (1934)[193], Gurley and Shaw (1955)[100], Goldsmith (1969)[92], McKinnon (1973)[151], Shaw (1973)[194], Greenwood & Jovanovic (1990)[96] and Bencivenga & Smith (1991)[41] acknowledged the important role of financial development in raising productivity and promoting economic growth. These economists gave the argument that the omission of finance from the economic growth explanation makes the discussion incomplete.

In traditional growth theory, main driving forces for economic growth are considered to be factor accumulation. Goldsmith (1969)[92] showed the contribution of financial development to growth of total factor productivity by raising marginal productivity of capital. McKinnon (1973)[151] and Shaw (1973)[194] expressed the role of financial development in improving the efficiency of capital allocation thus increasing the aggregate saving rates and investment levels. However, the impact of financial development in the traditional framework gets limited due to

the capital stock diminishing returns to scale [142].

A new theoretical underpinning to the analysis of relationship between financial development, productivity and economic growth, providing with important insights, emerged with the endogenous growth literature pioneered by Romer (1986)[187]. The endogenous technological progress through research and development (R & D) may result in non- diminishing capital returns thus effecting the aggregate productivity positively. Greenwood and Jovanovic (1990)[96] highlighted in their endogenous model two important functions of financial institutions and intermediaries in enhancing growth. Firstly, collection and analysis of investment projects and secondly, increase in the investment efficiency through allocation of the funds to the highest expected return projects. Bencivenga and Smith (1991)[41] focused in their endogenous model on the enhancement of liquidity and idiosyncratic risk mitigation through risk diversification. They argued that the developed financial intermediaries allocate funds efficiently and thus contribute to growth. The authors like Levine (1991)[139] and Saint-Paul (1992)[192] showed the importance of portfolio diversification and risk sharing via stock markets in inducing sustained growth.

The positive relation between financial development and economic growth also received considerable empirical support (for instance, see King and Levine (1993)[125], Beck et al.(2000)[38] and Levine et al.(2000)[141]). King and Levine (1994)[126] and Fry (1995)[86] argued that capital accumulation is the key factor for economic growth. However, Benhabib and Spiegel (2000)[42] examined both the channels through which the financial development affects the economic growth. Firstly, the primitive channel where the financial development affects growth solely through its contribution to factor accumulation as suggested in traditional growth theory and secondly, the channel of productivity improvements as highlighted by endogenous growth literature which is mainly attributed to knowledge creation and technological progress. They showed that financial development is positively correlated

with growth in both total factor productivity and investment.

In summary, there exists an important relationship between the finance and growth process as stressed by the widely agreed findings from the survey of the relevant theories, evidences and policy works in this area[95]. Both theoretical and empirical works give evidence that better functioning and efficient financial systems can lead to faster capital accumulation and higher productivity growth, by risk reduction and increased diversification, savings mobilization and best allocation of resources, corporate control exertion and managers monitoring, facilitation of exchange of goods and services and reduction of monitoring cost [140]. However, with the beginning of the banking crises in 2007, there is huge critic on financial deregulation arguing it either the cause or fuel for such crises. Critics also debated that deregulation allowed financial institutions to become too large and to take big risks that eventually made government to step in to avoid the failure and risk of damaging the entire economy.

Although, it is acknowledged that the financial development do impact the productivity and economic growth but still there exists gap regarding the mechanism through which the financial sector reforms can influence economic growth [66, 160]. The literature supporting the impact of financial development on productivity and economic growth does not provide consensus on the transmission mechanism. In the relevant current literature, a bi-directional causality between finance and economic growth, in which both are determined endogenously, is proposed. Advanced econometric techniques and instrumental approaches such as instrumental variable estimator approach and Generalized Method of Moments approach (GMM) are used in the empirical works due to the endogenous nature of the variables. These approaches help to control the endogeneity arising either due to the dynamic specification or due to reverse causation.

The current work investigates the relationship between financial development, economic growth and productivity for 103 countries by using the panel econometric

techniques[1]. Moreover, this work attempts to investigate the impact of remittances on economic growth and productivity. The link between remittances and financial development is also analyzed in aggregate for all the considered countries and also by considering the development state of the countries[2].

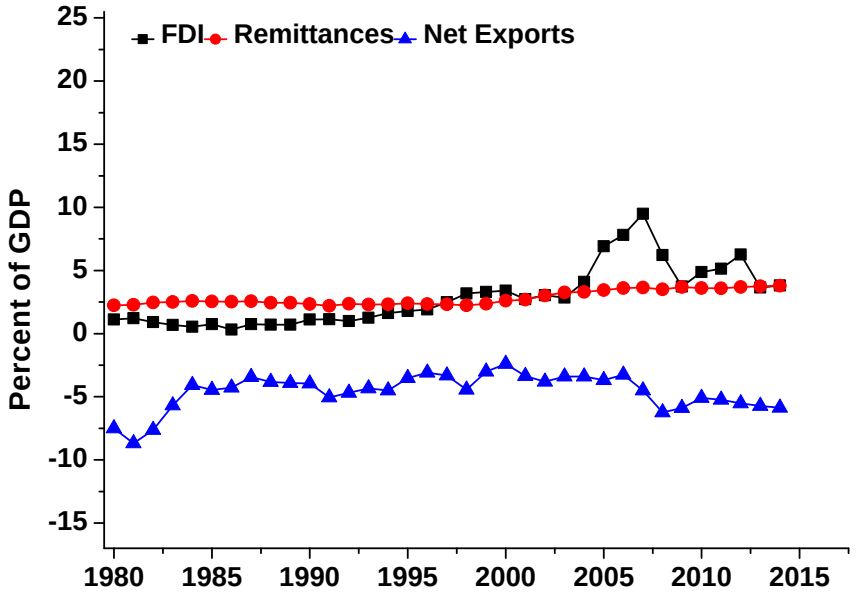
Remittances are the earnings of the workers working abroad and send to their homelands. These are different from other sources of foreign exchange (Net exports, FDI and international aids, etc.). For many developing countries remittances are a significant part of international capital flows, often exceeding the traditional sources such as export revenues, foreign aid and foreign direct investments (FDI)(see Ratha (2005)[179], Giuliano and Ruiz-Arranz (2009)[91], Aggarwal et al. (2011)[9], Rao and Hassan (2011)[178], Bettin and Zazzaro (2012)[46], Nyamongo et al.(2012)[165], Matuzeviciute and Butkus (2016) [150], Meyer and Shera (2017) [155], Hassan and Shakur (2017) [102]). Figure 4.1 presents the percentage share of the remittances to GDP along-with the percentage share of the net exports and FDI to GDP for 103 considered countries. During the first decade of 21st century remittances were the second biggest source of foreign exchange after FDI in aggregate. However, for the last couple of years remittances tend to be at par with FDI. Figure 4.2 presents the percentage share of FDI, net exports and remittances to GDP according to the development state of the countries. For the low and lower middle income countries the major contributor to foreign exchange reserves is remittances. The relative importance of remittance for the high income countries lies after FDI and Net Exports. Figure 4.3 shows the recipients of the remittances among the selected countries sharing more than 10% to GDP in the year 2010[3].

[1]List of selected countries given in Appendix C.1.

[2]Economies are categorized by using the World Bank income classification which assigns the countries into four income groups: high (> 12235), upper middle ($3956 - 12235$), lower middle ($1006 - 3955$) and low (< 1005) on the basis of GNI per capita in current US $

[3]Source World Bank Development Indicators and Author's calculations.

FIGURE 4.1: Remittances, Net Exports and FDI, 1980-2014



Remittances are private flows spent partly on consumption and partly on investment. The relevant literature on the role of remittances on growth and development suggested both positive and negative impacts of it on economic growth. Chami et al. (2005) [58], Amuedo- Dorantes and Pozo (2004) [19] found the negative impact of remittances on growth in their studies. There is asymmetric information as the r-emitter cannot control use of the remitted amount which may be intended to use on investment projects. Moreover, as remittances are mostly send to the households to fulfill consumption requirements, the recipients can prefer leisure over work, rendering negative impact on labor productivity and growth. Furthermore, remittances increase foreign exchange resources and flows which can appreciate the exchange rate leading to the country's competitiveness erosion in international trade. However, due to the time stable flow of remittances , the concerned "Dutch Disease" effects of remittances may not be trusted (IMF (2005)).

The welfare and supportive role of remittances in eradication of poverty of the

recipients (r-emitter relatives) is also highlighted in literature (see Chami, Fullenkamp and Gapen (2009)[59], Gupta et al. (2007)[98], Adams (2004) [5] and Richard, Adams H. Jr. Page, John (2003, 2005) [[181], [6]]). Increase in remittances during the economic downturns help to smooth household consumption [165]. Remittances tend to improve per capita income of the receiving countries but on the other hand it may lead to income inequalities. Moreover, remittances, as a source of savings and capital for investment, also effect the productivity and employment which lead to economic growth and development ([21], [215]). Furthermore, as remittances are also considered to be the part of export of goods and services, higher remittances enhance the debt to exports ratio, which is one of the indicators to assess credit worthiness of a country for international borrowing [165]. Remittances have become more acceptable as a collateral for international borrowing both in public and private sectors, due to their stable time profile [124]. Aggarwal et al. (2011) [9] highlighted the role of remittances in the growth of financial sector in recipient countries. When remittances are channelized through formal financial sector, on one hand it makes the receiver to open account in the bank and on the other increase the lending capacity of the commercial banks to the private sector.

According to the relevant literature there exists ambiguous relationship between remittances, financial development and economic growth. For instance, the well developed and functioning financial sector, through information and transaction costs minimization, can help to utilize remittances into suitable and profitable projects bearing high yield, leading to increased growth. On the other hand, in case of bad or weak financial markets, remittances can help to resolve the liquidity problems, credit constraints, collateral issues and high lending costs by providing entrepreneur with the start-up capital and funds for productive activities. The former attributes to the complementary behavior of the remittances and financial development leading to growth, whereas, the latter presents the substitute role of remittances for financial development in growth process.

The present work seeks to add to the existing literature in this field by making the following contributions: (1) The impact of the financial development on economic growth and productivity growth are studied. Non-parametric growth accounting technique is used to estimate the productivity growth. (2) The effect of remittances on economic growth and productivity is also highlighted along-with the impact of remittance volatility. (3) The growth effect of remittances by using financial sector development level on economic growth and productivity is also studied. (4) Moreover, the analysis is further done by categorizing the countries into high, upper middle, lower middle and low income groups which reveals that development state of the countries does influence the estimates. Considering the literature reviewed on this subject this area is not yet fully explored. (5) Large set of cross country panel data containing 103 countries for the period of 35 years (from 1980 to 2014) is covered in the current study.

The structure of the paper is as follows. Section 4.1 is the introduction. In section 4.2 the estimation methodology is described. The data description is given in the section 4.3. The empirical analysis is done in the section 4.4. The last section 4.5 presents the conclusions.

4.2 Estimation Methodology

A panel data-set consisting of 103 developing and developed countries is used to analyze the relationship among remittances, financial development and growth. The equations considered for econometric estimations are as follow:

$$GGDP_{it} = \beta_0 + (\beta_1 - 1)y_{i,t-1} + \beta_2 X_{it} + \beta_3 W_{it} + \eta_t + \upsilon_i + \varepsilon_{it} \tag{4.1}$$

where $GGDP$ is growth rate of real GDP per capita. y is real GDP per capita and $((\beta_1 - 1)$ is the convergence coefficient. X_{it} is the set of explanatory variables including financial development, remittances and the interaction terms. W_{it} is the set of control variables including openness (sum of exports and imports to GDP), foreign direct investment, inflation, and education. η_t and υ_i denote the time and country specific effects. ε_{it} is the error term.

$$GTFP_{it} = \alpha_0 + \alpha_1 y_{i,t-1} + \alpha_2 X_{it} + \alpha_3 W_{it} + \eta_t + \upsilon_i + \varepsilon_{it} \tag{4.2}$$

where $GTFP$ is the total factor productivity growth. Malmquist TFP index method[57] is used to estimate total factor productivity, which measures the change between two data points by calculating the ratio of the distances of each data point relative to a common technology. The Malmquist (output-oriented) TFP change index between base period t and current period $t+1$ is given by:

$$M_o(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{d_o^t(y_{t+1}, x_{t+1})}{d_o^t(y_t, x_t)} \frac{d_o^{t+1}(y_{t+1}, x_{t+1})}{d_o^{t+1}(y_t, x_t)} \right]^{\frac{1}{2}}$$

The value of M_o greater than one indicates positive TFP growth from period t to period $t+1$[4].

Following the related empirical literature, three indicators of financial development in a country are used:Domestic credit to private sector (PRVT) as a ratio to GDP, claims on central government (CGOV) as a ratio to GDP and the ratio of broad money supply to GDP (M2). PRVT is the most common measure of financial inter-mediation and refers to the financial resources provided to the private sector by financial corporations as a share of GDP. The financial corporations include monetary authorities, deposit money banks, finance and leasing companies, money lenders, insurance corporations, pension funds and foreign exchange

[4]Data Envelopment Analysis Program (DEAP) Software version 2.1 by Tim J. Coelli is used (CRS and output orientation).

companies. PRVT represents the actual resources channeled to the private sector. The indicator CGOV refers to the claims on the central government including loan to public institutions net of deposits divided by GDP. The PRVT and CGOV are used to measure the financial depth. The M2 is a monetization variable and is also most commonly used measure of financial development[54, 125]. A higher ratio of M2 presents more financial inter-mediation and larger financial sector, showing real size of the country's financial sector. This ratio increases over time when the growth of financial sector exceeds the growth of real sector[165]. The volatility of M2 (DM2) is computed from the ratio of M2 to GDP as a proxy for the available financial liquidity (the proxy for volatility is the standard deviation of this ratio over a period of three years).

Remittances comprise of the personal transfers and compensations of employees where former include all current transfers between residents and non-resident individuals. The latter attribute to the income of workers (border, seasonal and other short-term workers) who are residents and employed in a non-resident entity and of nonresidents employed by the resident economy[5]. The volatility in remittance is calculated from the ratio of remittances to GDP and the proxy for it is the deviation of remittances from its three year trend. The high volatility in remittances is expected to have dampening effect on the growth of receiving country, as negative shock in remittances reduce the availability of funds and capital for productive activities and investments.

The interaction term is also incorporated (FD.Rem) to show the impact of remittances on economic growth and productivity growth with the financial development. There is an ongoing debate in related literature on whether financial development and remittances are complements or substitutes. The supporters of substitutability hypothesis argue that in emigration countries the lack of financial

[5]See sixth edition of the IMF's Balance of Payments Manual: personal transfers and compensation of employees.

development is relaxed by remittances as this permits poor people to invest in profitable investment projects even though there are difficulties in attaining credit[6]. However, the complementary hypothesis suggests that financial development and remittances support each other. It argues, that when there is a high degree of financial development, the migrants can send more money home safely at faster and cheaper rate . The larger amount of remittances may stimulate the interests of financial institutions and government authorities by increasing the competition among themselves. Moreover, the better institutional reforms may be taken in order to channelize the remittances toward productive investments[7].

The following four variables are included as control variables to capture the impact of macroeconomic stability. Openness which is commercial openness divided by GDP (exports plus imports divided by GDP). Foreign direct investment (FDI) is the net inflows of investment (new investment inflows less disinvestment) in the economy from the foreign investors and is divided by GDP. Inflation (INF) shows the future market degree of uncertainty and is measured as the annual change in the consumer price index. Moreover, the variable education (EDU), showing the average years of primary school of the country's total population, is used as a control for human capital accumulation.

4.3 Data Description

The real GDP data is obtained from PWT 9.0. Real GDP using national accounts growth rates is used as it helps to compare (output-based) growth rates across countries[8]. The data for all the three proxies of financial development is obtained from the World Data Bank: World Development Indicators. The claims

[6]See Calderón et al.(2008)[53], Giuliano and Ruiz-Arranz (2009)[91].
[7]See Nyamongo et al.(2012)[165], Aggarwal et al. (2011)[9] and Martínez et al.(2008)[148].
[8]'rgdpna' Real GDP at constant national prices (in mil. 2011 US dollar).

on central government (CGOV) as a ratio to GDP, include loans to central government institutions net of deposits. Domestic credit to private sector (PRVT) as a ratio to GDP refers the financial resources (such as loans, purchases of non-equity securities, trade credits and other accounts receivable which are subject to repayment) are given to the private sector by financial corporations (finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies). The money supply M2 is frequently defined as "the money and quasi money comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government"[9]. Data on remittances as a ratio of GDP is also taken from the World Data Bank source. Personal remittances are the sum of two items defined in the sixth edition of the IMF's Balance of Payments Manual: personal transfers and compensation of employees.

The World Data Bank: world development indicators source is also used to obtain data for the four control variables. Exports and Imports of goods and services represent the value of all goods and other market services provided to and received by the rest of the world, respectively. FDI is the ratio of foreign direct investments (net inflows) to GDP. Inflation measured by the consumer price index highlights the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. Gross primary enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.

[9]See World Data Bank: World development indicators.

The data for the Malmquist productivity index including real GDP (Output)[10], physical capital[11] and labor[12] (inputs) is taken from the PWT 9.0.

Table 4.1 presents the descriptive statistics of the variables used in the study. Bi-variate Correlations between the variables considered are shown in table 4.2. GDP growth is positively related with trade openness, years of education, FDI and negatively related with inflation. The correlation between GDP growth and CGOV is negative, whereas, the correlations between PRVT and M2 with GDP growth are positive. The relation between remittances and GDP growth is also positive. The correlations between proxies of financial development are positive (CGOV and M2) with remittances. However, it is negative between PRVT and remittances. The correlation of total factor productivity growth (GTFP) with PRVT is negative but really small, moreover, with the other two proxies of financial development the correlations are positive. Remittances and years of education are negatively correlated with GTFP.

Figure 4.4 presents the five year averages (from 1980 to 2014) of the proxies for financial development and remittances for 103 considered countries. The domestic credit and M2 as percentage of GDP show growth in the financial sector of the economies. Moreover, remittances are also improved from about 2.41% to 3.69% on average. Figure 4.5 gives the five year averages of the considered countries on the basis of their state of development. Countries are categorized by using the World Bank income classification which assigns the economies into four income groups: high (greater than 12235), upper middle (3956 - 12235), lower middle (1006 - 3955) and low (less than 1005) on the basis of GNI per capita in current US $. For high income countries the percent share of all the financial development proxies tends to increase over considered period of time, whereas, remittances percent share in GDP diminishes on average. The growth of the financial sector in low income countries is relatively low however, the percentage share of remittances in GDP has increased from 1% to 5.76% on average. For upper and lower middle

[10]'rgdpo' Output side real GDP at PPPs (in mil. 2011 US dollar).
[11]'rkna' Capital stock at constant national prices (in mil. 2011 US dollar).
[12]'emp' Number of persons engaged (in millions)

income countries the percentage increase of remittances is steady at around 1% on average for the whole considered time period, however, there is a decline in the percentage share of CGOV in GDP for both states of development.

4.4 Estimation Results

In order to explore the impact of financial development and remittances on growth and productivity a panel data-set comprising of 103 countries for the period of 1980-2014 is used. Panel econometric technique, ordinary least squares (OLS) is used. Moreover, to address the issue of endogeneity, for instance, the plausible impact of higher economic growth and productivity on remittances and financial development leading to overstatement of effects, instrumental variable estimation techniques (IV-2SLS and IV-GMM) are employed. The Sargan- Hansen test of over-identifying restrictions is performed, under the null hypothesis that the instruments are valid, that is the instruments are uncorrelated with the error term and from the estimated equation the excluded instruments are correctly excluded . Anderson Canonical Correlations LM statistic is used to test whether the equation is identified and that the excluded instruments are relevant, meaning correlated with the endogenous regressors. In robust case Kleibergen- Paap rk under-identification test statistic is used. Moreover, when the excluded instruments are correlated with the endogenous regressors (only weakly) the problem of "Weak identification" arises, resulting into the poor performing estimators due to weak instruments[13]. Cragg Donal Wald F statistic is used. Stock and Yogo (2005) compiled the critical values for this statistic. In robust case ivreg2 reports a correspondingly- robust Kleibergen- Paap Wald rk F statistic.

At first the impact of financial development on growth is estimated by using the equation 4.1, where, X_{it} only consists of the proxies of financial development.

[13]See STATA help ivreg2

Table 4.3 presents the relationship between financial development and GDP per capita growth using OLS, IV-2SLS and IV-GMM. The estimated results are in line with the previous literature in this field. The impact of financial development proxies, that is claims on central government as a ratio to GDP, domestic credit to private sector as ratio to GDP and money supply (M2) as a ratio to GDP, have positive and significant impact on growth. The volatility of money supply has negative and significant estimates, highlighting the dampening effect of volatile financial liquidity on growth. The estimated coefficients of years of schooling and foreign direct investments are positive and significant, whereas, the initial level of GDP per capita and inflation have negative and significant impact on economic growth.

The tables 4.4 and 4.5, present the range of results showing the impact of remittances, financial development and interaction terms on economic growth by employing OLS and Instrumental variable techniques, respectively, using data-set for 103 countries for the period of 35 years from 1980-2014. Estimated coefficients of remittances are positive and significant both at the conventional level of testing and when financial development proxies for instance, interaction terms are included into the analysis. This suggests the important positive role of remittances on economic growth. The volatility of remittances under OLS models tend to have negative but insignificant impact on growth. However, under instrumental variable models the impact of remittance volatility is negative and significant. The results are in line with the previous works, highlighting the dampening effect of remittance volatility on economic growth. However, as some of the estimated coefficients are, although, negative but insignificant, results do not provide with the strong confirmation.

Estimated coefficients of financial development proxies are positive and significant confirming the previous findings that financial development effect the economic growth positively. The positive or negative signs of the interaction terms reveal the complementary or substitute nature of remittances and financial development, respectively. For instance, the positive sign indicates that financial development

and remittances complement each other whereas, the negative sign reveals that both substitute each other to enhance economic growth. The negative and significant interaction term estimates in tables 4.4 and 4.5 confirm the substitution hypothesis, suggesting that remittances positively impact the economic growth in the absence of or weaker financial sector. Remittances help to channel resources by providing funds, insurance and credits for the productive activities in countries with shallow financial development.

The lagged GDP per capita variable estimates in all the models in both tables are found to be negative and for some models it is significant too thus supporting the conditional convergence hypothesis that poor countries grow faster than the richer countries. The results are also in line with the neoclassical model in which case an economy with the low per capita income at the beginning tends to approach its long run position. Trade openness mostly show positive but non significant impact on the growth. The average years of primary education and foreign direct investment show positive and significant estimates, boosting economic growth. The coefficient estimates for inflation are negative and significant.

Table 4.6 presents the relationship among remittances, financial development and total productivity growth using instrumental variables methodology[14]. The estimated coefficients for remittances are negative and insignificant, showing no impact of remittances on productivity growth. Moreover, the impact of financial development on productivity growth is also negative but insignificant. The interaction terms have positive signs implying the complementary hypothesis that financial development supports the remittances to enhance productivity growth. However, due to the insignificant results, the evidence is not enough to support this hypothesis. Trade openness have positive and significant impact on productivity growth.

[14]OLS estimates provide non-significant results in most models.

The development level of countries also influence the relationship between financial sector, remittances and economic growth. Tables 4.7, 4.8, 4.9, 4.10 and 4.11 presents the range of results considering the state of development of countries where, countries are categorized by World Bank income classification. For high income countries (hc) the estimated coefficients for remittances are mostly positive but insignificant suggesting less important role of remittance in growth. The influence of the proxies of financial development on growth is also mixed but insignificant in most of the cases suggesting no impact of financial development on economic growth for developed economies. Moreover, the interaction term coefficients are negative but mostly insignificant, except for the interaction term CG.REM which is negative and significant supporting the substitution hypothesis. However, in general, for high income countries the results suggest that financial development does not play role in making remittances productive. Moreover, countries with the developed financial markets reliance on remittances for growth is less as the well functioning banking system performs all the needed financial activities necessary to channelize productive investments.

The impact of financial development, in case of the low income countries (LC), on growth appears to be negative and significant under OLS methodology and also under instrumental variable techniques where, the domestic credits to private sector (PRVT) as ratio to GDP have dampening effect on economic growth. The results are in line with the findings by Papadavid, Rewilak and Brighty (2017) [169], suggesting that the reasons of low growth can be the successive banking crises or deregulation of financial sector. Other reason can be the fragility of financial system in low income countries [70]. The high default rates, which limit the future supply of credit and hamper the future investments and lending, can also be the reason behind this negative impact. The estimated coefficients on remittances in the low income countries are positive but significant only in three models (under OLS LC.2 & LC.3 and IV-GMM 3). In low income countries remittances are mostly used to meet the immediate consumption requirements. Previous related literature highlighted the role of remittances in poverty eradication of the recipient

families than on the economic growth as a whole. Moreover, there is also a possibility among the individual households to choose leisure instead of work because of easy money, leading to decline in labor supply which poses negative impact on long-run economic growth. The estimated results for all the interaction terms are insignificant highlighting that there exist neither complementary nor substitution relationship between remittances and financial development. It is possible that due to fragile financial system and banking crises the remittances are not rooted through the formal official channels which reduces the role of financial sector and also of the government to control the use of remittances in a productive way.

The estimated outcomes for the Upper middle income countries are presented in table 4.10. The role of financial development on economic growth as shown by the estimated coefficients is although positive but insignificant. Remittances show negative and significant impact on economic growth. The reason can be that increase in remittances may increase the consumption of non-tradable goods leading to rise in their prices. This appreciates the real exchange rate and decreases exports, damaging the receiving country's competitiveness in the world markets. The results for the interaction terms support the substitution hypothesis as the signs of estimated outcomes are negative. This suggests that in case of weak financial markets remittances help to finance credit and funds for the productive activities, helping to boost economic growth.

Table 4.11 presents the range of results considering the data for 27 low middle income countries. The financial development proxy money supply (M2) as ratio to GDP estimated outcomes are positive and significant showing that increase in money supply helps to boost economic growth. Remittances also show positive and significant impact on growth. Moreover, the interaction terms influence economic growth in mixed manner however, the estimates are mostly insignificant. This shows that remittances do not act either as substitute or complement to financial development. The hypothesis that financial development helps to use

the funds received from migrants into productive activities is not supported by the estimated results. The cause can be the less developed financial markets in lower middle income countries, or the cost of opening the account at the recipient's country is too high or the receiver of the funds only use the banking system to get the money and spends it immediately on the household consumption.

The wide range of results can be summarized into the following. Considering the whole set of considered data the financial development impact the economic growth positively. Remittances impact is also growth boosting. The substitution hypothesis is supported highlighting the positive role of remittances in the absence of or weaker financial sector in remittance- growth nexus. However, the results vary when the countries are categorized on their income basis. In case of higher and upper middle income countries the impact of remittances on growth is mostly insignificant. The financial development estimated outcomes provide with the weak confirmation that it influences the economic growth positively. The substitution hypothesis is supported for the upper middle income countries as estimated results of the interaction terms are negative and significant. The impact of remittances and financial development (M2) are positive and significant on economic growth for the lower middle income countries, furthermore, there is no support for either complementary hypothesis or substitution hypothesis. For the low income countries the impact of remittances is positive but not strongly confirmed as most of the results are positive but insignificant. Moreover, the fragile and weak financial sector negatively impact the economic growth. Interaction terms results neither support the substitution nor complementary hypothesis between remittances and financial development.

4.5 Conclusion

The current work analyzes the impact of financial development (ratio of domestic credit provided to the private sector to GDP, ratio of claims on central government

to GDP and ratio of money supply to GDP), remittances and their interaction term on economic growth and changes in total productivity by using panel data for 103 countries over the period of 35 years from 1980-2014. The main findings suggest the positive and significant role of financial development and remittances on economic growth. Moreover, the substitution hypothesis is supported, which suggests that in the absence of or in case of weak and shallow financial markets, remittances provide with the financial help both for consumption as well as for productive investment activities. The role of financial development and remittances on productivity growth appears to be negative but insignificant.

Furthermore, analysis is also done by categorizing the countries using the World Bank income classifications. The findings suggest that the development state of the countries also influence the impact of remittances, financial sector and interaction term on economic growth. In case of high income countries remittances and financial development appear to have insignificant impact on economic growth. However, the results support the substitution hypothesis.

For low income countries the impact of remittances is positive but insignificant on economic growth, suggesting that in poor countries the remittance funds are immediately used for the consumption purpose, which helps to eradicate individual poverty, rather than on investment projects and productive activities. Moreover, weaker and fragile financial markets, banking structure and deregulation show negative impact on growth. The outcomes suggest neither substitution nor complementary role of financial development and remittances. The influence of remittances and financial development on economic growth is strongly positive in case of lower middle income countries. For upper middle income countries the substitution hypothesis is supported that remittances help to provide funds, unrestricted credit and better lending opportunities to the households to participate in productive activities and profitable investments.

The study also provides with the following policy implications. The effective financial sector improvements and policies should be carried out in remittance- growth nexus to reap benefits of this less volatile and time stable foreign exchange inflow. The policy makers, advisers and researchers should develop and formulate such policies for the development of financial sector that it should facilitate and support the receipt and use of remittances in most effective and useful manner.The measures should also be taken by the governments of the developing countries to enhance and develop the official and formal channels to direct the flow of remittances in the economies. This will help in minimizing the remittance volatility, money laundering and misuse of funds on illegal activities.

FIGURE 4.2: State of Development, Remittances, Net Exports and FDI

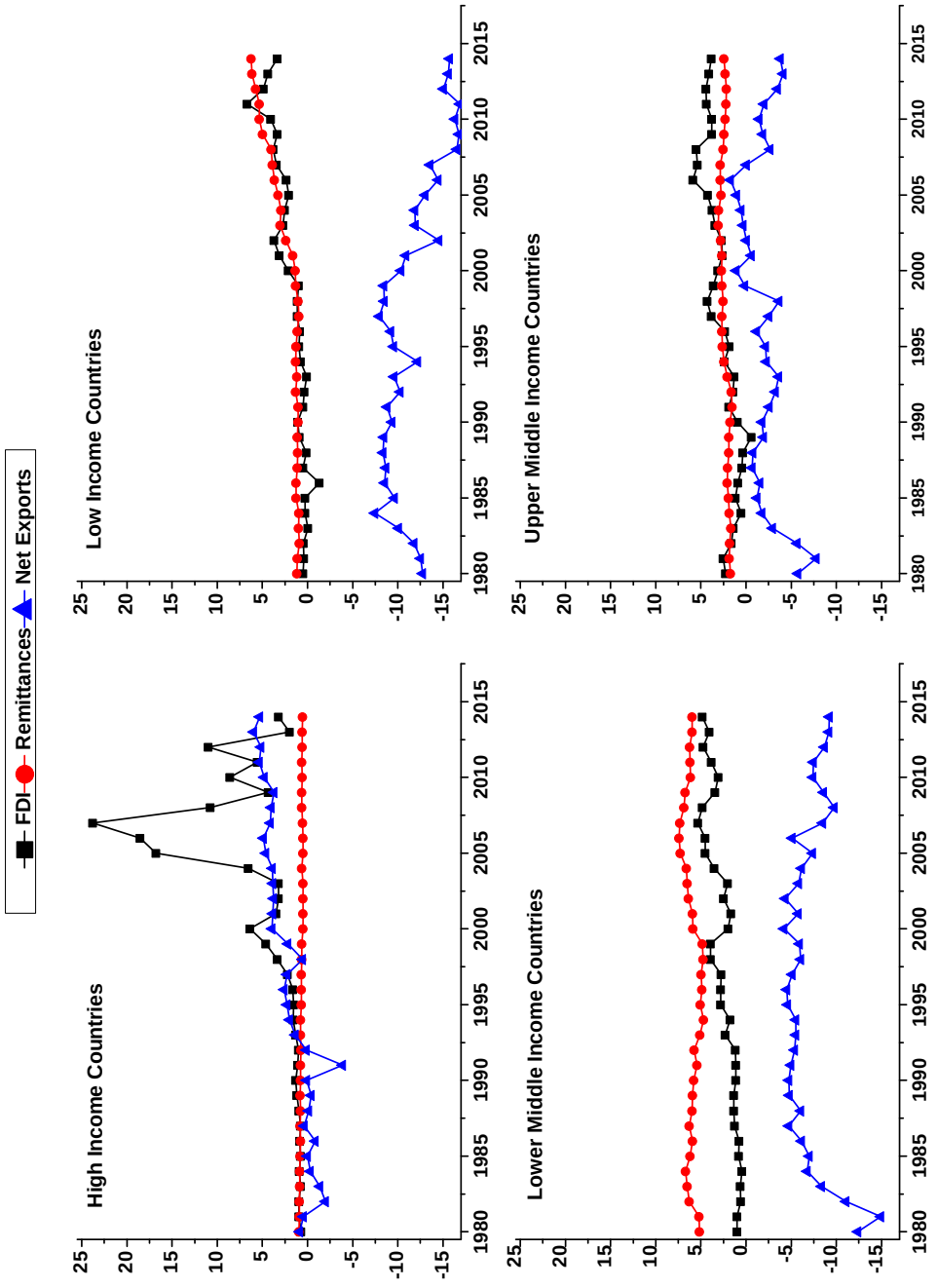


FIGURE 4.3: Recipients of Remittances, 2010

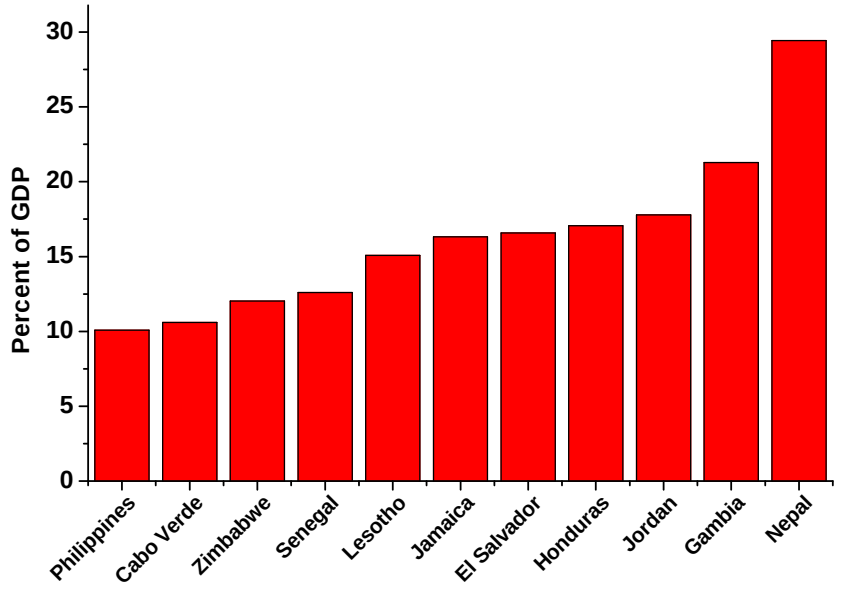


FIGURE 4.4: Financial Development and Remittances

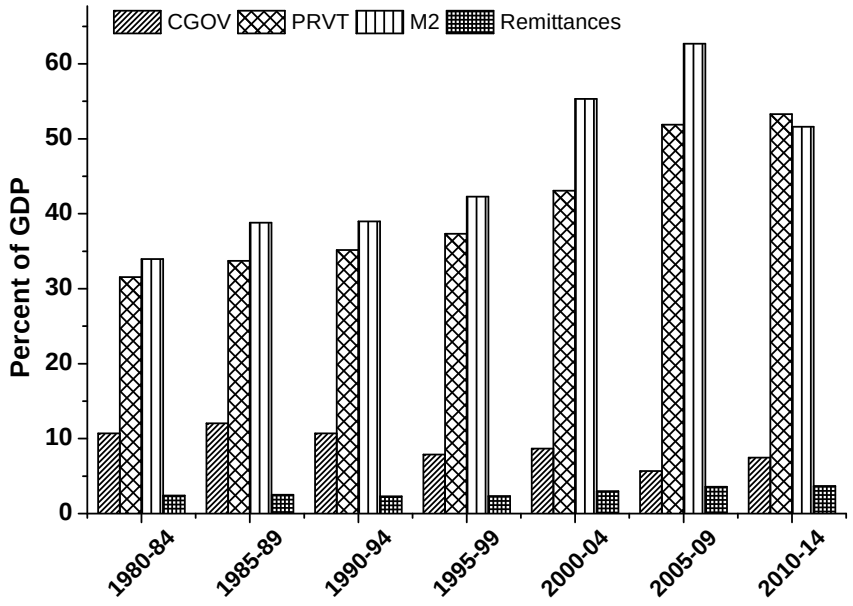


Table 4.1: Descriptive Statistics

Variable	TFP	GDP	CGOV	PRVT	M2	REM	Openness	FDI	INF	EDU
Mean	1.0098	518848	0.0934	0.4486	0.4946	0.0278	0.6967	0.0302	0.4727	0.8863
Std. Dev.	0.0831	1517826	0.1727	0.4186	0.4235	0.0659	0.3734	0.1324	6.7055	0.3599
Min.	0.3100	321	-0.9378	0.0020	0.0161	0.0000	0.0632	-0.5524	-0.3584	0.1729
1st Qu.	0.977	13699	0.005	0.1557	0.2183	0.0012	0.4419	0.0035	0.0221	0.8317
Median	1.0090	63388	0.0671	0.2962	0.3811	0.0064	0.6195	0.0131	0.0525	1.0117
3rd Qu.	1.040	355593	0.1533	0.6075	0.6548	0.0290	0.9022	0.0327	0.1140	1.0795
Max.	2.0510	17150538	2.1173	3.1212	2.8340	0.9982	3.2706	4.5171	244.1103	1.6565
Obs.	3502	3605	3526	3524	3309	3168	3564	35448	3482	3220
Cross Sec.	103	103	103	103	103	103	103	103	103	103

Where TFP is productivity growth, GDP is gross domestic product, CGOV is the ratio of claims on government to GDP, PRVT is the ratio of domestic credit to GDP, M2 is the ratio of broad money to GDP, REM is the ratio of personal remittances received to GDP, Openness is the ratio of exports plus imports of goods and services to GDP, FDI is the ratio of foreign direct investments (net inflows) to GDP, INF is the inflation rate, EDU is the gross primary enrollment rate.

Table 4.2: Correlations of Variables of Interest

a.	GGDP	CGOV	PRVT	M2	REM	Openness	FDI	INF	EDU	
GGDP	1									
CGOV	-0.0447	1								
PRVT	0.0503	0.1684	1							
M2	0.0853	0.1664	0.678	1						
REM	0.0925	0.054	-0.051	0.0301	1					
Openness	0.0732	-0.1439	0.2667	0.308	0.1576	1				
FDI	0.1308	-0.1383	0.1699	0.2196	0.1591	0.3365	1			
INF	-0.0906	0.1206	-0.3429	-0.2526	0.0383	-0.2482	-0.1576	1		
EDU	0.0787	-0.0387	0.1955	0.1519	0.091	0.0951	0.1592	0.0332	1	
b.	GTFP	GDP	CGOV	PRVT	M2	REM	Openness	FDI	INF	EDU
GTFP	1									
GDP	-0.0507	1								
CGOV	0.0199	0.0121	1							
PRVT	-0.0099	0.6186	0.166	1						
M2	0.0103	0.4621	0.1716	0.7271	1					
REM	-0.0084	-0.317	0.0522	-0.0521	0.0402	1				
Openness	0.0221	0.1862	-0.1426	0.2652	0.3363	0.1572	1			
FDI	0.0082	-0.1998	-0.1168	-0.043	0.0406	0.2424	0.2412	1		
INF	0.0003	-0.3562	0.1214	-0.3413	-0.2953	0.0396	-0.2433	0.039	1	
EDU	-0.0206	0.0786	-0.0395	0.1965	0.1669	0.0934	0.0981	0.1445	0.0363	1

FIGURE 4.5: State of Development, Financial Development and Remittances

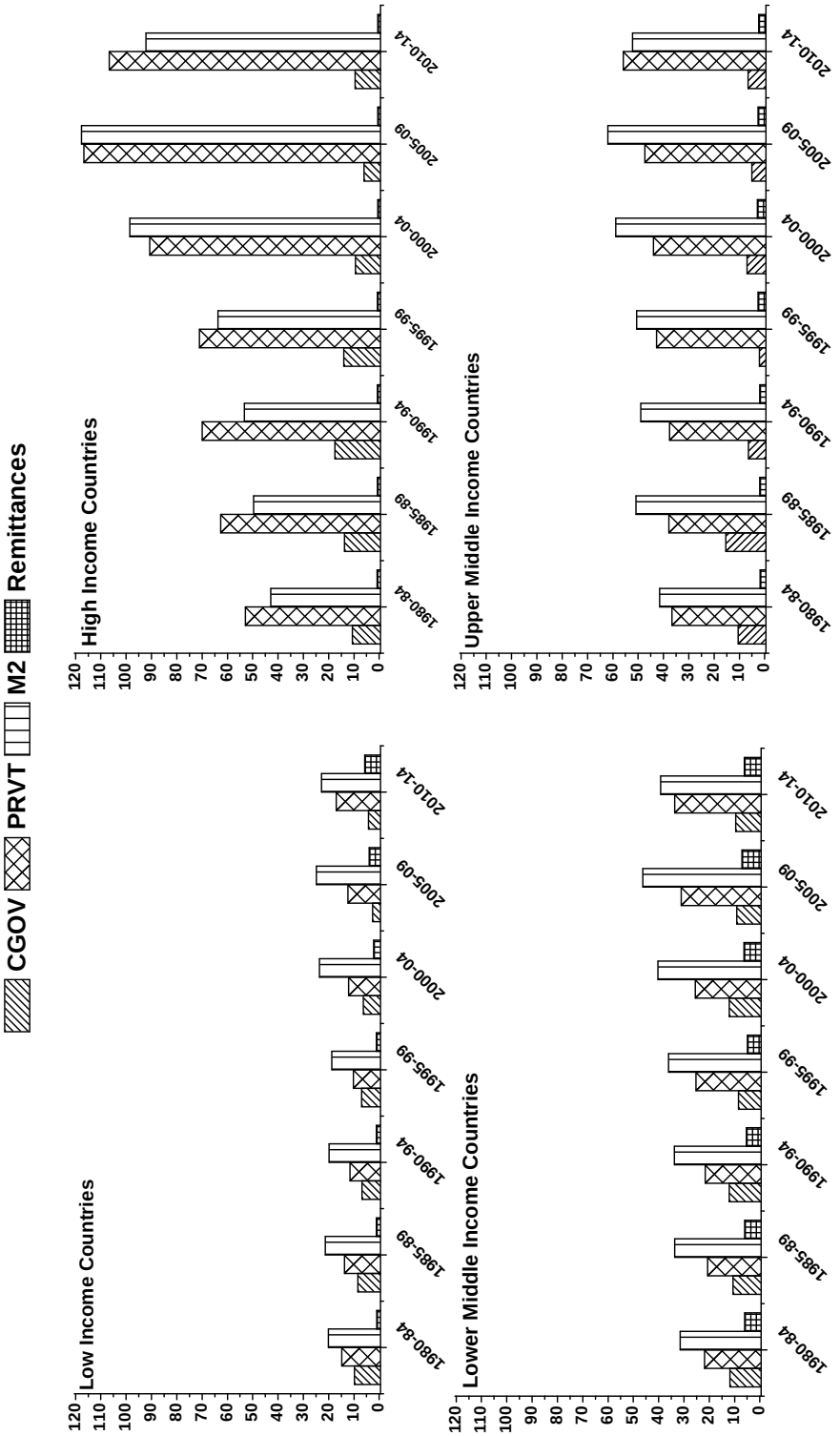


TABLE 4.3: **Financial Development**. Dependent Variable: Growth of GDP per capita

	OLS			IV-2SLS	IV-GMM		
VARIABLES	1	2	3	1	1	2	3
YPC(-1)	-3.09e-07***	-3.95e-07***	-3.82e-07***	-2.90e-07***	-2.84e-07***	-3.67e-07***	-3.71e-07***
	(5.61e-08)	(6.45e-08)	(5.88e-08)	(5.70e-08)	(6.70e-08)	(8.71e-08)	(7.02e-08)
Openness	9.80e-07	7.46e-07	4.85e-07	8.82e-07	8.30e-07	4.19e-07	7.55e-08
	(8.38e-07)	(8.40e-07)	(8.48e-07)	(8.54e-07)	(7.60e-07)	(7.83e-07)	(7.80e-07)
FDI	3.72e-06***	3.50e-06***	3.28e-06***	4.12e-06***	4.31e-06***	3.99e-06***	3.74e-06***
	(8.93e-07)	(8.96e-07)	(8.92e-07)	(8.99e-07)	(9.43e-07)	(9.75e-07)	(9.69e-07)
INF	-4.95e-06***	-4.53e-06***	-3.90e-06***	-4.85e-06***	-4.75e-06***	-3.88e-06***	-2.90e-06**
	(8.94e-07)	(9.06e-07)	(9.04e-07)	(9.11e-07)	(1.09e-06)	(1.13e-06)	(1.16e-06)
EDU	3.46e-06***	3.02e-06***	2.89e-06***	3.49e-06***	3.49e-06***	3.03e-06***	2.92e-06***
	(8.06e-07)	(8.22e-07)	(8.08e-07)	(8.18e-07)	(8.66e-07)	(8.09e-07)	(8.24e-07)
CGOV	-3.16e-07			1.63e-06*	1.55e-06*		
	(7.93e-07)			(8.72e-07)	(8.13e-07)		
PRVT		2.57e-06***				2.73e-06**	
		(9.73e-07)				(1.36e-06)	
M2			6.08e-06***				7.13e-06***
			(1.07e-06)				(1.49e-06)
DM2			-4.59e-06***				-5.06e-06***
			(9.74e-07)				(1.26e-06)
Observations	3,502	3,502	3,502	3,296	3,296	3,296	3,296
R-squared	0.067	0.069	0.077	0.060	0.061	0.063	0.069

Standard errors in parentheses (OLS, IV-2SLS). Robust standard errors in parentheses (IV-GMM) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. YPC is GDP per capita. DM2 is the standard deviation of M2 as ratio to GDP over three years. Time specific coefficients and constants are not reported here for brevity.

Table 4.4: Dependent Variable: Growth of GDP per capita (OLS)

Variables	1	2	3	4	5	6	7
YPC(-1)	-2.56e-07***	-2.47e-07***	-3.33e-07***	-3.56e-07***	-3.27e-07***	-3.72e-07***	-3.79e-07***
	(6.08e-08)	(6.14e-08)	(7.04e-08)	(7.07e-08)	(6.46e-08)	(6.54e-08)	(6.53e-08)
Openness	6.69e-07	3.79e-07	3.07e-07	5.51e-07	-8.12e-08	3.61e-08	2.31e-07
	(8.47e-07)	(8.61e-07)	(8.59e-07)	(8.62e-07)	(8.69e-07)	(8.67e-07)	(8.66e-07)
FDI	3.61e-06***	3.66e-06***	3.44e-06***	3.42e-06***	3.33e-06***	3.47e-06***	3.38e-06***
	(8.93e-07)	(8.95e-07)	(8.96e-07)	(8.95e-07)	(8.96e-07)	(8.94e-07)	(8.93e-07)
INF	-4.93e-06***	-4.90e-06***	-4.51e-06***	-4.40e-06***	-4.58e-06***	-4.38e-06***	-3.76e-06***
	(8.91e-07)	(8.94e-07)	(9.06e-07)	(9.05e-07)	(8.93e-07)	(8.93e-07)	(9.03e-07)
EDU	3.33e-06***	3.45e-06***	2.96e-06***	3.01e-06***	3.04e-06***	2.94e-06***	2.78e-06***
	(8.07e-07)	(8.10e-07)	(8.23e-07)	(8.22e-07)	(8.10e-07)	(8.09e-07)	(8.08e-07)
REM	2.00e-06**	3.00e-06***	2.42e-06**	4.74e-06***	2.33e-06**	5.86e-06***	5.04e-06***
	(8.81e-07)	(1.03e-06)	(1.01e-06)	(1.27e-06)	(1.01e-06)	(1.33e-06)	(1.34e-06)
DREM		-9.96e-07	-1.36e-06	-8.66e-07	-1.40e-06	-7.24e-07	-6.88e-07
		(9.95e-07)	(9.83e-07)	(9.95e-07)	(9.81e-07)	(9.94e-07)	(9.91e-07)
CGOV		3.10e-07					
		(9.20e-07)					
CG.REM		-1.94e-06*					
		(1.10e-06)					
PRVT			2.38e-06**	3.31e-06***			
			(9.80e-07)	(1.03e-06)			
PR.REM				-3.76e-06***			
				(1.24e-06)			
M2					3.52e-06***	5.09e-06***	7.12e-06***
					(9.45e-07)	(1.02e-06)	(1.13e-06)
M2.REM						-5.94e-06***	-5.37e-06***
						(1.47e-06)	(1.48e-06)
DM2							-4.07e-06***
							(9.83e-07)
Obs.	3,502	3,502	3,502	3,502	3,502	3,502	3,502
R-squared	0.069	0.070	0.071	0.073	0.073	0.077	0.082

Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP respectively. Time specific coefficients and constants are not reported here for brevity.

TABLE 4.5: Dependent Variable: Growth of GDP per capita (IV-2SLS & IV-GMM)

	IV-2SLS			IV-GMM			
VARIABLES	1	2	3	1	2	3	4
YPC(-1)	-1.93e-07***	-2.09e-07***	-3.13e-07***	-1.95e-07**	-2.01e-07**	-3.02e-07***	-3.61e-07***
	(6.39e-08)	(6.43e-08)	(7.56e-08)	(8.05e-08)	(8.13e-08)	(9.86e-08)	(8.40e-08)
Openness	4.18e-09	3.84e-08	1.43e-07	-9.57e-08	-2.38e-08	1.16e-07	-2.46e-07
	(8.78e-07)	(8.86e-07)	(8.82e-07)	(7.80e-07)	(7.82e-07)	(8.00e-07)	(7.94e-07)
FDI	3.92e-06***	4.10e-06***	3.66e-06***	4.04e-06***	4.28e-06***	3.88e-06***	3.86e-06***
	(8.99e-07)	(9.02e-07)	(9.03e-07)	(9.42e-07)	(9.45e-07)	(9.72e-07)	(9.63e-07)
INF	-4.62e-06***	-4.80e-06***	-4.04e-06***	-4.49e-06***	-4.69e-06***	-3.74e-06***	-2.80e-06**
	(9.06e-07)	(9.11e-07)	(9.26e-07)	(1.07e-06)	(1.08e-06)	(1.11e-06)	(1.14e-06)
EDU	3.30e-06***	3.53e-06***	2.98e-06***	3.36e-06***	3.52e-06***	3.01e-06***	2.79e-06***
	(8.19e-07)	(8.23e-07)	(8.36e-07)	(8.50e-07)	(8.44e-07)	(7.97e-07)	(8.15e-07)
REM	3.73e-06***	4.11e-06***	6.62e-06***	3.75e-06***	4.17e-06***	6.56e-06***	6.71e-06***
	(1.19e-06)	(1.21e-06)	(1.58e-06)	(1.18e-06)	(1.20e-06)	(1.61e-06)	(1.76e-06)
DREM	-1.77e-06*	-1.31e-06	-1.23e-06	-1.68e-06*	-1.26e-06	-1.22e-06	-7.75e-07
	(1.02e-06)	(1.03e-06)	(1.02e-06)	(8.86e-07)	(8.82e-07)	(8.76e-07)	(8.66e-07)
CGOV		2.92e-06***			2.78e-06***		
		(1.04e-06)			(9.96e-07)		
CG.REM		-3.76e-06***			-3.67e-06***		
		(1.14e-06)			(9.87e-07)		
PRVT			3.67e-06***			3.57e-06**	
			(1.14e-06)			(1.40e-06)	
PR.REM			-5.03e-06***			-4.92e-06***	
			(1.37e-06)			(1.39e-06)	
M2							8.34e-06***
							(1.58e-06)
M2.REM							-7.01e-06***
							(1.72e-06)
DM2							-4.30e-06***
							(1.25e-06)
Observations	3,296	3,296	3,296	3,296	3,296	3,296	3,296
R-squared	0.064	0.062	0.066	0.064	0.062	0.066	0.072

Standard errors in parentheses (IV-2SLS). Robust standard errors in parentheses (IV-GMM) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP, respectively. Time specific coefficients and constants are not reported here for brevity.

Table 4.6: GTFP as a dependent variable (IV-2SLS & IV-GMM)

	IV-2SLS		IV-GMM				
VARIABLES	1	2	1	2	3	4	5
YPC(-1)	-7.33e-08	-7.01e-08	-1.34e-07	-6.77e-08	-5.78e-08	-8.90e-08	-1.62e-08
	(2.08e-07)	(2.10e-07)	(2.48e-07)	(2.49e-07)	(2.95e-07)	(2.61e-07)	(2.68e-07)
Openness	5.56e-06**	5.55e-06**	4.99e-06**	4.99e-06**	3.88e-06*	3.76e-06*	3.59e-06
	(2.40e-06)	(2.41e-06)	(2.43e-06)	(2.38e-06)	(2.28e-06)	(2.26e-06)	(2.29e-06)
FDI	2.20e-06	2.14e-06	1.44e-06	1.22e-06	4.28e-07	2.81e-07	1.55e-07
	(3.13e-06)	(3.13e-06)	(3.22e-06)	(3.19e-06)	(2.93e-06)	(3.05e-06)	(3.03e-06)
INF	3.76e-06	3.83e-06	3.23e-06	4.27e-06	1.89e-06	2.00e-06	1.84e-06
	(2.50e-06)	(2.52e-06)	(2.92e-06)	(2.85e-06)	(2.95e-06)	(3.05e-06)	(3.06e-06)
EDU	-4.54e-06**	-4.64e-06**	-3.83e-06	-3.31e-06	-2.67e-06	-2.24e-06	-2.17e-06
	(2.27e-06)	(2.28e-06)	(2.65e-06)	(2.63e-06)	(2.59e-06)	(2.51e-06)	(2.51e-06)
REM	-2.84e-06	-3.03e-06	-2.69e-06	-2.58e-06	-3.96e-06	-7.70e-07	-5.16e-06
	(2.89e-06)	(2.94e-06)	(2.97e-06)	(3.07e-06)	(4.88e-06)	(2.93e-06)	(5.09e-06)
DREM	1.23e-06	1.03e-06	1.05e-06	-5.63e-07	1.28e-06	1.84e-06	9.67e-07
	(2.75e-06)	(2.79e-06)	(2.71e-06)	(2.45e-06)	(2.70e-06)	(2.64e-06)	(2.82e-06)
CGOV		-1.20e-06		-1.03e-06			
		(2.86e-06)		(2.46e-06)			
CG.REM		1.60e-06		1.42e-06			
		(3.15e-06)		(2.84e-06)			
PRVT					-3.42e-06		
					(4.31e-06)		
PR.REM					3.67e-06		
					(5.29e-06)		
M2						-4.27e-06	-6.09e-06
						(3.91e-06)	(4.10e-06)
M2.REM							7.03e-06
							(5.99e-06)
DM2						3.40e-06	3.06e-06
						(3.14e-06)	(3.20e-06)
Observations	3,193	3,193	3,193	3,193	3,193	3,193	3,193
R-squared	0.053	0.052	0.053	0.052	0.051	0.050	0.049

Standard errors in parentheses (IV-2SLS). Robust standard errors in parentheses (IV-GMM) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP, respectively. Time specific coefficients and constants are not reported here for brevity.

TABLE 4.7: **State of Development**. Dependent Variable: Growth of GDP per capita (OLS)

	HC	LC.1	LC.2	LC.3	LMC.1	LMC.2	UMC
YPC(-1)	-7.11e-07***	-1.81e-05**	-1.72e-05**	-1.57e-05**	-1.59e-06**	-1.85e-06**	-2.61e-06***
	(1.27e-07)	(7.24e-06)	(7.20e-06)	(7.31e-06)	(7.39e-07)	(7.56e-07)	(4.18e-07)
Openness	5.67e-06	0.000208	0.0101	0.0108	-5.17e-06	-4.95e-06	7.97e-06
	(5.37e-06)	(0.0142)	(0.0143)	(0.0143)	(5.11e-06)	(5.02e-06)	(6.20e-06)
FDI	3.86e-07	-1.30e-05	-1.89e-05	-1.80e-05	1.33e-05***	1.37e-05***	1.80e-05***
	(5.53e-06)	(1.74e-05)	(1.75e-05)	(1.74e-05)	(5.00e-06)	(5.00e-06)	(6.12e-06)
INF	-1.24e-05**	-3.81e-05**	-6.14e-05***	-4.58e-05***	-3.26e-06	-2.47e-06	-2.43e-05***
	(5.76e-06)	(1.66e-05)	(1.62e-05)	(1.61e-05)	(4.90e-06)	(4.90e-06)	(6.70e-06)
EDU	1.76e-06	4.61e-05***	6.02e-05***	5.56e-05***	1.71e-06	1.35e-06	-2.62e-06
	(4.97e-06)	(1.61e-05)	(1.68e-05)	(1.66e-05)	(4.97e-06)	(4.87e-06)	(5.39e-06)
REM	1.91e-06	3.42e-05	6.13e-05**	5.16e-05*	2.24e-05***	2.28e-05**	-1.00e-05
	(5.90e-06)	(2.68e-05)	(2.87e-05)	(2.96e-05)	(6.20e-06)	(9.33e-06)	(7.61e-06)
DREM	-2.02e-06	-1.72e-05	-2.35e-05	-1.54e-05	-6.44e-07	-4.59e-07	2.70e-06
	(5.39e-06)	(2.58e-05)	(2.66e-05)	(2.68e-05)	(6.12e-06)	(6.12e-06)	(7.10e-06)
CGOV	6.56e-06	-3.39e-05*			-6.70e-06		
	(5.73e-06)	(1.77e-05)			(6.38e-06)		
CG.REM	-2.14e-05***	5.71e-06			1.24e-05*		
	(6.56e-06)	(2.56e-05)			(7.10e-06)		
PRVT			-4.77e-05***				-2.11e-06
			(1.64e-05)				(5.87e-06)
PR.REM			-9.07e-06				-1.41e-05*
			(2.44e-05)				(7.81e-06)
M2				-3.17e-05*		1.68e-05***	
				(1.84e-05)		(6.13e-06)	
M2.REM				-4.95e-06		-4.52e-06	
				(2.89e-05)		(9.62e-06)	
DM2				-3.90e-05**		-5.90e-06	
				(1.64e-05)		(5.02e-06)	
Obs.	1,054	612	612	612	918	918	918
R-squared	0.146	0.142	0.149	0.157	0.156	0.160	0.208

HC: High Income Countries, LC: Low Income Countries, LMC: Lower Middle Income Countries, UMC: Upper Middle Income Countries. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP, respectively. Time specific coefficients and constants are not reported here for brevity.

TABLE 4.8: **High Income Countries**. Dependent Variable: Growth of GDP per capita (IV-2SLS & IV-GMM)

	IV-2SLS		IV-GMM			
VARIABLES	1	2	1	2	3	4
YPC(-1)	-5.72e-07***	-5.66e-07***	-5.32e-07***	-6.16e-07***	-4.88e-07***	-5.49e-07***
	(1.31e-07)	(1.33e-07)	(1.41e-07)	(1.41e-07)	(1.39e-07)	(1.38e-07)
Openness	7.23e-06	8.11e-06	6.02e-06	3.68e-06	8.66e-06**	7.62e-06
	(5.52e-06)	(5.56e-06)	(5.23e-06)	(5.17e-06)	(4.26e-06)	(4.91e-06)
FDI	2.01e-06	1.86e-06	3.61e-06	4.42e-06	5.61e-06	4.17e-06
	(5.53e-06)	(5.53e-06)	(5.74e-06)	(5.75e-06)	(5.39e-06)	(5.79e-06)
INF	-1.41e-05**	-1.36e-05**	-9.80e-06*	-8.88e-06*	-8.53e-06	-7.65e-06
	(5.95e-06)	(5.96e-06)	(5.29e-06)	(5.22e-06)	(5.35e-06)	(5.25e-06)
SCH	1.45e-06	1.39e-06	1.30e-06	3.11e-06	1.76e-07	3.21e-07
	(5.10e-06)	(5.11e-06)	(4.52e-06)	(4.43e-06)	(3.78e-06)	(4.82e-06)
REM	-5.15e-07	1.10e-05	2.40e-06	4.61e-06	1.37e-05	7.62e-06
	(6.47e-06)	(1.60e-05)	(6.29e-06)	(6.23e-06)	(1.38e-05)	(7.50e-06)
DREM	-3.17e-06	-3.41e-06	-2.84e-06	-1.29e-06	-3.91e-06	-3.62e-06
	(5.39e-06)	(5.42e-06)	(3.74e-06)	(3.85e-06)	(3.29e-06)	(3.70e-06)
CGOV				6.68e-06		
				(5.53e-06)		
CG.REM				-2.08e-05***		
				(4.86e-06)		
PRVT	-7.62e-06	-3.19e-06			-5.68e-07	
	(5.91e-06)	(8.65e-06)			(8.39e-06)	
PR:REM		-1.37e-05			-1.66e-05	
		(1.55e-05)			(1.29e-05)	
M2						8.67e-06
						(1.06e-05)
M2.REM						-1.24e-05
						(1.37e-05)
DM2						-4.22e-06
						(9.41e-06)
Observations	992	992	992	992	992	992
R-squared	0.126	0.126	0.122	0.121	0.122	0.111

Standard errors in parentheses (IV-2SLS). Robust standard errors in parentheses (IV-GMM) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP, respectively. Time specific coefficients and constants are not reported here for brevity.

TABLE 4.9: **Low Income Countries**. Dependent Variable: Growth of GDP per capita (IV-2SLS & IV-GMM)

	IV-2SLS				IV-GMM			
VARIABLES	1	2	3	4	1	2	3	4
YPC(-1)	-2.48e-05***	-2.34e-05***	-2.22e-05***	-2.54e-05***	-2.44e-05***	-2.01e-05***	-2.18e-05***	-2.52e-05***
	(7.67e-06)	(7.84e-06)	(7.69e-06)	(7.90e-06)	(6.33e-06)	(6.20e-06)	(6.38e-06)	(6.60e-06)
Openness	0.00795	0.00594	0.0128	0.00924	0.00278	-0.000441	0.00980	0.00817
	(0.0145)	(0.0146)	(0.0146)	(0.0147)	(0.0135)	(0.0136)	(0.0136)	(0.0144)
FDI	1.17e-05	8.15e-06	1.71e-06	1.02e-05	5.27e-06	9.85e-07	-4.41e-06	5.77e-06
	(1.56e-05)	(1.57e-05)	(1.61e-05)	(1.61e-05)	(1.61e-05)	(1.68e-05)	(1.60e-05)	(1.62e-05)
INF	-5.28e-05***	-4.42e-05***	-6.07e-05***	-4.10e-05**	-4.48e-05***	-3.18e-05	-5.42e-05***	-3.10e-05*
	(1.56e-05)	(1.66e-05)	(1.57e-05)	(1.61e-05)	(1.68e-05)	(1.96e-05)	(1.67e-05)	(1.87e-05)
EDU	7.28e-05***	7.28e-05***	8.53e-05***	6.93e-05***	7.86e-05***	7.64e-05***	9.14e-05***	7.59e-05***
	(1.52e-05)	(1.51e-05)	(1.59e-05)	(1.61e-05)	(1.74e-05)	(1.72e-05)	(1.62e-05)	(1.63e-05)
REM	3.40e-05	2.96e-05	6.12e-05	3.15e-05	5.68e-05	4.47e-05	8.20e-05*	5.01e-05
	(3.71e-05)	(3.82e-05)	(4.17e-05)	(4.31e-05)	(4.29e-05)	(4.08e-05)	(4.43e-05)	(4.41e-05)
DREM	-8.73e-06	-3.49e-07	-1.41e-05	7.70e-06	-3.09e-05	-1.97e-05	-3.49e-05	-1.54e-05
	(3.06e-05)	(3.08e-05)	(3.07e-05)	(3.14e-05)	(3.71e-05)	(3.51e-05)	(3.81e-05)	(3.62e-05)
CGOV		-2.30e-05				-3.89e-05*		
		(2.16e-05)				(2.31e-05)		
CG.REM		-1.45e-05				-9.76e-06		
		(2.74e-05)				(2.12e-05)		
PRVT			-4.09e-05**				-4.53e-05**	
			(1.79e-05)				(1.81e-05)	
PR.REM			-1.36e-05				-1.07e-05	
			(2.54e-05)				(2.05e-05)	
M2				2.35e-05				2.36e-05
				(2.53e-05)				(2.50e-05)
M2.REM				-1.92e-05				-1.31e-05
				(3.02e-05)				(2.27e-05)
DM2				-5.09e-05***				-6.25e-05***
				(1.75e-05)				(2.12e-05)
Observations	576	576	576	576	576	576	576	576
R-squared	0.074	0.083	0.094	0.077	0.075	0.086	0.095	0.077

Standard errors in parentheses (IV-2SLS). Robust standard errors in parentheses (IV-GMM) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP, respectively.
Constants are not reported here for brevity.

TABLE 4.10: **Upper Middle Income Countries**. Dependent Variable: Growth of GDP per capita (IV-2SLS & IV-GMM)

	IV-2SLS				IV-GMM			
VARIABLES	1	2	3	4	1	2	3	4
YPC(-1)	-3.06e-06***	-2.94e-06***	-2.82e-06***	-3.05e-06***	-2.97e-06***	-2.70e-06***	-2.53e-06***	-3.04e-06***
	(4.23e-07)	(4.27e-07)	(4.45e-07)	(4.56e-07)	(5.48e-07)	(5.35e-07)	(5.43e-07)	(5.72e-07)
Openness	5.12e-06	4.76e-06	6.44e-06	7.11e-06	4.54e-06	3.91e-06	6.15e-06	7.37e-06
	(6.27e-06)	(6.34e-06)	(6.29e-06)	(6.74e-06)	(5.75e-06)	(5.85e-06)	(5.98e-06)	(6.54e-06)
FDI	1.80e-05***	1.80e-05***	1.80e-05***	1.96e-05***	1.80e-05***	1.84e-05***	1.85e-05***	1.97e-05***
	(6.00e-06)	(6.02e-06)	(6.11e-06)	(6.06e-06)	(5.64e-06)	(5.67e-06)	(5.80e-06)	(5.68e-06)
INF	-1.96e-05***	-2.00e-05***	-2.29e-05***	-2.23e-05***	-2.01e-05***	-2.11e-05***	-2.53e-05***	-2.27e-05***
	(6.33e-06)	(6.32e-06)	(6.60e-06)	(6.60e-06)	(7.08e-06)	(7.07e-06)	(7.34e-06)	(7.63e-06)
EDU	-4.76e-07	3.86e-07	-1.34e-06	-2.22e-06	-4.38e-07	1.34e-06	-4.03e-07	-2.33e-06
	(5.31e-06)	(5.35e-06)	(5.34e-06)	(5.43e-06)	(5.66e-06)	(5.74e-06)	(5.66e-06)	(5.80e-06)
REM	-1.62e-05**	-1.59e-05*	-5.93e-06	-9.43e-06	-1.52e-05*	-1.37e-05*	-2.64e-06	-8.97e-06
	(8.16e-06)	(8.24e-06)	(9.82e-06)	(1.12e-05)	(8.03e-06)	(8.06e-06)	(9.81e-06)	(1.17e-05)
DREM	-2.30e-06	1.81e-06	4.27e-06	2.24e-06	-2.70e-06	1.83e-06	4.74e-06	2.42e-06
	(6.86e-06)	(7.00e-06)	(7.03e-06)	(6.96e-06)	(6.50e-06)	(6.69e-06)	(6.61e-06)	(6.14e-06)
CGOV		4.83e-06				4.08e-06		
		(6.45e-06)				(6.51e-06)		
CG.REM		-1.45e-05**				-1.38e-05**		
		(6.85e-06)				(6.78e-06)		
PRVT			-7.74e-07				-7.31e-07	
			(6.08e-06)				(6.42e-06)	
PR.REM			-2.08e-05**				-2.28e-05***	
			(8.28e-06)				(8.50e-06)	
M2				-5.48e-06				-6.38e-06
				(7.80e-06)				(8.72e-06)
M2.REM				-1.49e-05				-1.53e-05
				(1.01e-05)				(1.04e-05)
DM2				-1.32e-06				-1.68e-06
				(6.18e-06)				(5.72e-06)
Observations	864	864	864	864	864	864	864	864
R-squared	0.206	0.208	0.211	0.208	0.206	0.208	0.209	0.207

Standard errors in parentheses (IV-2SLS). Robust standard errors in parentheses (IV-GMM) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP, respectively.
Time specific coefficients and constants are not reported here for brevity.

TABLE 4.11: **Lower Middle Income Countries**.Dependent Variable: Growth of GDP per capita (IV-2SLS & IV-GMM)

	IV-2SLS				IV-GMM			
VARIABLES	1	2	3	4	1	2	3	4
YPC(-1)	-1.46e-06**	-1.59e-06**	-1.68e-06**	-1.75e-06**	-1.44e-06**	-1.55e-06**	-1.66e-06***	-1.73e-06***
	(7.12e-07)	(7.22e-07)	(7.65e-07)	(7.38e-07)	(5.86e-07)	(6.04e-07)	(6.16e-07)	(5.92e-07)
Openness	-6.51e-06	-5.67e-06	-6.79e-06	-5.78e-06	-6.45e-06	-5.75e-06	-6.74e-06	-5.76e-06
	(4.89e-06)	(5.01e-06)	(4.90e-06)	(4.94e-06)	(4.71e-06)	(4.78e-06)	(4.68e-06)	(4.82e-06)
FDI	1.21e-05**	1.23e-05**	1.26e-05***	1.33e-05***	1.18e-05**	1.19e-05**	1.24e-05**	1.31e-05**
	(4.88e-06)	(4.88e-06)	(4.89e-06)	(4.88e-06)	(5.15e-06)	(5.15e-06)	(5.16e-06)	(5.20e-06)
INF	-1.42e-06	-6.10e-07	-6.01e-07	3.87e-07	-1.71e-06	-9.97e-07	-8.13e-07	3.40e-07
	(4.74e-06)	(4.79e-06)	(4.85e-06)	(4.81e-06)	(5.45e-06)	(5.28e-06)	(5.69e-06)	(5.57e-06)
SCH	-1.30e-06	-1.41e-06	-9.34e-07	-1.79e-06	-1.27e-06	-1.45e-06	-8.13e-07	-1.77e-06
	(4.76e-06)	(4.85e-06)	(4.82e-06)	(4.77e-06)	(5.16e-06)	(4.99e-06)	(5.15e-06)	(5.15e-06)
REM	3.94e-05***	3.71e-05***	4.55e-05***	4.72e-05***	3.95e-05***	3.76e-05***	4.65e-05***	4.95e-05***
	(6.56e-06)	(7.03e-06)	(8.82e-06)	(1.25e-05)	(6.53e-06)	(7.23e-06)	(1.01e-05)	(1.50e-05)
DREM	-9.17e-06	-9.49e-06	-8.37e-06	-9.35e-06	-9.12e-06	-9.35e-06	-8.26e-06	-9.34e-06
	(6.30e-06)	(6.27e-06)	(6.28e-06)	(6.35e-06)	(6.44e-06)	(6.44e-06)	(6.34e-06)	(6.46e-06)
CGOV		-3.60e-06				-3.11e-06		
		(6.28e-06)				(7.28e-06)		
CG.REM		7.99e-06				6.87e-06		
		(7.19e-06)				(9.36e-06)		
PRVT			6.37e-06				6.63e-06	
			(5.18e-06)				(5.27e-06)	
PR.REM			-1.10e-05				-1.22e-05	
			(7.27e-06)				(9.19e-06)	
M2				1.78e-05***				1.85e-05**
				(5.99e-06)				(7.36e-06)
M2.REM				-1.86e-05				-2.14e-05
				(1.17e-05)				(1.65e-05)
DM2				-6.45e-06				-6.80e-06
				(4.85e-06)				(4.72e-06)
Observations	891	891	891	891	891	891	891	891
R-squared	0.157	0.159	0.156	0.161	0.156	0.159	0.155	0.160

Standard errors in parentheses (IV-2SLS). Robust standard errors in parentheses (IV-GMM) $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. PR.REM, CG.REM and M2.REM are the interaction terms. YPC is GDP per capita. DREM and DM2 are the standard deviation of ratio of remittances and M2 to GDP, respectively. Time specific coefficients and constants are not reported here for brevity.

Chapter 5

Conclusions

In this dissertation three essays are presented addressing three different questions in economic growth and development. The second chapter focuses on the mystery of growth transitions and the shifts in growth performance within a country, highlighting the fact that average growth rates mask very distinct growth paths. The weaknesses of both the statistical and filter-based approaches, to identify structural breaks in growth series, are overcome by using a variant of unified Fit and Filter technique [121]. The new methodology provided improved results firstly, by identifying the breaks in case of volatile growth series generally pertaining to the developing countries and secondly, by correctly identifying the false breaks in case of very smooth growth series. Moreover, the proximate sources of growth transitions are determined by using non-parametric growth accounting. DEA-Based Malmquist Productivity Index approach is used to decompose the productivity growth into efficiency change, technological progress, capital deepening and human capital accumulation.

The results of the structural break analysis show that the structural breaks occur in all regions of the world. However, up-breaks are more common in the low, lower middle and upper middle income countries as compared to the high income

countries where down-breaks occur more common. This confirms the view that developing countries do not remain in the poverty trap, rather sustainability of the once achieved positive growth is crucial. The findings in this work also suggest that for both positive and negative breaks sources of productivity growth are asymmetric. In case of positive breaks, the sources of productivity growth are factor accumulation following the efficiency improvements. Whereas, in the case of negative breaks, decline in efficiency is the main cause of productivity slow down. The results suggest that efficient reallocation of the resources can help the developing countries to achieve positive and sustainable growth paths, leading to technological improvements. A further study focus can be on the determination of sources of efficiency changes, which can give better insight and understanding upon the reasons of poverty gaps between rich and poor countries and further provide with the guidelines to formulate suitable policies for the developing countries to get on the prosperity track.

In chapter 3, Nation's progress and its determinants, a two-stage approach, the influence of potential economic, institutional, demographic and geographic determinants on the progress of a nation is examined. Nation's progress is measured by using not only the economic factors but also social, environmental and human welfare variables. The performance of a nation is measured as an estimated efficiency score within which it transforms a given number of endowments such as human and physical capital into national well-being and general human welfare. The economic, environmental and human well-being yardsticks, namely GDP per capita, persons employed, carbon dioxide emission and availability of clean water with proper sanitation facilities are used in this works to measure the nation's progress. The estimated bias adjusted performance scores in stage 1 are regressed on the potential covariates. Simar and Wilson's double bootstrap procedure is used, which allows valid inferences in the presence of an unknown serial correlation in the efficiency scores. The second stage results reveal that the considered covariates play a significant role in the progress of a nation.

The results presented in this chapter suggest many further framework scenarios, which can be used to increase the nation's progress and enhance the welfare and well-being of a country. After the financial system crises, partly caused by the amplified stress on material growth at all costs, it is realized that actual and balanced growth and development is being neglected. The requirement now is to set new goals and establish new ways to estimate progress. The new goals should consider social, ecological welfare along-with sustainable economic well-being, moreover, proper measures and strategies should be adapted to achieve those goals. Policy makers should focus on plans and strategies to better allocate the resources and funds. Conducive environment and suitable institutional set-up helps to strengthen the performance of a nation. Moreover, trustworthy institutional environment along-with suitable economic policies helps to reap more benefits from demographic and geographic factors, which otherwise either need a lot of time and effort to change (population composition) or cannot be altered (geography). The impact of the linguistic fractionalization and ethnic differences can be reduced by redistributing the funds to all sections of the population and by providing all with the equal access to education and other social benefits.

The fourth chapter shows the impact of financial development and remittances on economic and productivity growth. A panel of 103 countries including developed and developing economies over the period 1980-2014 is used to study the role of financial development, remittances and interaction terms on economic growth and total productivity. A panel econometric framework is used and the findings of the study suggest positive role of financial development and remittances on economic growth. Moreover, the results also support the substitution hypothesis suggesting the relaxing role of remittances in case of weak financial sector in the receiving countries. However, the role of financial development and remittances on productivity growth is insignificant. The findings also suggest that the development state of countries also effects the corresponding roles of remittances,

financial development and interaction terms on economic growth. The study provides the following policy implications. The effective financial sector improvements and policies should be carried out in remittance- growth nexus to reap benefits of this less volatile and time stable foreign exchange inflow (remittances). The policy makers, advisers and researchers should develop and formulate such policies for the development of financial sector that it should facilitate and support the receipt and use of remittances in most effective and useful manner.The measures should also be taken by the governments of the developing countries to enhance and develop the official and formal channels to direct the flow of remittances in their economies. This will help in minimizing the remittance volatility, money laundering and misuse of funds on illegal activities.

Appendix A.1

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ ABW	1981	1989
◦ AGO	1994	1986
		2006
◦ AIA	1982	1990
		2006
◦ ALB	1994	1986
		2006
◦ ARE	1988	1980
		2004
◦ ARG	1959	1977
	1985	1994
	2002	
◦ ARM	1998	
◦ ATG	1978	1989
		2006
◦ AUS	1961	1969
◦ AUT		1977

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ AZE	1998	
◦ BDI	1969	1977
	1996	1988
	2006	
◦ BEL		1974
◦ BEN	1978	1986
	1994	
◦ BFA	1967	1978
	1994	
◦ BGD	1972	
◦ BGR	1997	1988
		2006
◦ BHR	1986	1978
◦ BHS	1978	1986
	1994	2002
◦ BIH		1998
◦ BLR	1998	
◦ BLZ	1986	1978
		1994
		2004
◦ BMU	1994	2006
◦ BOL	1959	1967
	1986	1978
	2005	
◦ BRA	1967	1980

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ BRB	1995	1970
		2006
◦ BRN	1987	1979
		2006
◦ BTN	1982	1990
◦ BWA	1969	1977
		1989
◦ CAF	1996	1978
		2006
◦ CAN	1961	
	1996	
◦ CHE		1973
		1990
◦ CHL	1959	1967
	1975	1997
	1986	
◦ CHN	1968	1960
	1977	1985
	2001	
◦ CIV	1988	1978
	2006	1998
◦ CMR	1976	1984
	1994	

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ COD	1982	1958
	2001	1974
		1990
◦ COG	1977	1969
	1994	1985
◦ COL	2003	1978
		1995
◦ COM		1968
		1984
◦ CPV	1977	1969
	1993	1985
		2006
◦ CRI	1986	1958
		1978
◦ CYM		1990
		1998
◦ CYP	1964	1972
		1990
		2006
◦ CZE	1998	
◦ DEU		1960
◦ DJI	1978	
	1989	
	2005	
◦ DMA	1979	1988

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ DNK	1958	1969
		2006
◦ DOM	1968	1960
	1990	1976
◦ DZA	1971	1979
	1995	
◦ ECU	1971	1979
	1987	
	2003	
◦ EGY	1975	1984
◦ ESP	1982	1974
		2006
◦ EST	1999	
◦ ETH	1992	1968
	2003	1984
◦ FIN	1993	1974
		1985
		2006
◦ FJI	1969	1979
	1987	
◦ FRA		1973
◦ GAB	1968	1976
	1987	1998
	2006	

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ GBR	1981	1973
		1989
		2006
◦ GEO	1998	
◦ GHA	1983	1963
	2006	1974
◦ GIN	1970	1978
	1994	
◦ GMB		1982
◦ GNB	1971	1979
	1987	1997
	2005	
◦ GNQ	1969	1977
	1986	2004
	1995	
◦ GRC	1961	1972
	1996	2006
◦ GRD	1997	1979
		1989
		2005
◦ GTM	1962	1979
	1987	
◦ HKG	2002	1994
◦ HND	1963	1979
◦ HRV	1999	

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ HTI	1970	1980
◦ HUN	1996	1978
		1988
		2006
◦ IDN	1969	1996
	1988	
	2004	
◦ IND	1979	1969
	2003	
◦ IRL	1958	2002
	1986	
	1994	
◦ IRN	1988	1969
		1977
		2006
◦ IRQ	1995	1979
		1987
		2004
◦ ISL	1969	1978
	1995	1987
		2006
◦ ISR		1972
◦ ITA		1970
		2006

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ JAM	1980	1961
	1988	1972
◦		1996
◦ JOR	1974	1965
	1991	1982
		2006
◦ JPN	1958	1970
		1990
◦ KAZ	1998	
◦ KEN	2003	1967
◦ KGZ	1998	
◦ KHM	1980	1988
	1998	2006
◦ KNA	1982	1990
		2006
◦ KOR	1962	1978
	1970	1996
◦ KWT	1982	1998
	1990	2006
◦ LAO	1979	
◦ LBN	1989	1980
		1997
◦ LBR	1995	1971
		1987
		2003

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ LCA	1981	1989
◦ LKA	1959	
	2005	
◦ LSO	1970	1978
	1987	
◦ LTU	1999	
◦ LUX	1966	1974
	1983	1991
		2006
◦ LVA	1998	
◦ MAC	2002	1978
		1994
◦ MAR	1960	1969
	1995	
◦ MDA	1998	
◦ MDG	1982	1971
	1998	
◦ MDV	1978	1986
	2005	
◦ MEX	1989	1981
◦ MKD	1998	
◦ MLI	1969	1977
	1985	

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ MLT	1964	1980
	1972	2000
	1988	
◦ MMR	1990	1970
	1998	1982
		2006
◦ MNE	1999	
◦ MNG	1994	1986
	2002	
◦ MOZ	1985	1976
	1995	2003
◦ MRT	1984	1968
	2006	1976
◦ MSR	1978	1990
	1998	2006
◦ MUS	1960	1976
	1968	
	1984	
◦ MWI	1960	1968
	1984	1976
	1997	
◦ MYS	1970	1979
	1987	1997
◦ NAM	1990	1970
		1980

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ NER	1987	1968
	2004	1979
◦ NGA	1968	1960
	1984	1976
	2001	1992
◦ NIC	1959	1967
	1993	1977
◦ NLD		1974
		2001
◦ NPL	1980	
◦ NZL	1958	1966
	1992	
◦ OMN		1978
		1986
		2002
◦ PAK	1960	1970
	1979	
◦ PAN	1960	1971
	1989	1981
	2005	
◦ PER	1992	1966
		1974
		1982
◦ PHL	1987	1959
	2003	1979

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ POL	1994	1978
◦ PRT	1984	1974
		1992
		2001
◦ PRY	1964	1982
	1972	
	2006	
◦ PSE	1989	1980
	2006	1998
◦ QAT	1987	1979
	1996	2004
◦ ROU	1992	1976
	2000	1984
◦ RUS	1998	
◦ RWA	1968	1986
	1994	2002
◦ SAU	1987	1979
	2003	1995
◦ SDN	1989	1978
	1997	2006
◦ SEN	1994	
◦ SGP	1968	1981
		1997
◦ SLE	1998	1970
	2006	1990

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ SLV	1986	1978
◦ SRB	1999	
◦ STP	1987	1979
	2004	
◦ SUR	1994	1978
	2002	
◦ SVK	2000	
◦ SVN		2006
◦ SWE	1996	1970
		2006
◦ SWZ	1986	1978
◦ SYC	1969	1979
	1987	1998
	2006	
◦ SYR	1970	1981
	1989	1998
		2006
◦ TCA		2006
◦ TCD	1981	1971
	1997	1989
		2005
◦ TGO	1987	1969
	2005	1979
		1997

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ THA	1958	1970
	1986	1995
◦ TJK	1998	
◦ TKM	1998	
◦ TTO	1973	1961
	1989	1981
	1997	2006
◦ TUN	1968	1976
	1995	2006
◦ TUR	1967	1958
	1984	1976
	2001	1993
◦ TWN	1962	1978
		1994
◦ TZA	1984	1968
	1998	1976
◦ UGA	1961	1969
	1980	
	1988	
◦ UKR	1998	
◦ URY	1968	1958
	1985	1976
	2003	1994
◦ USA	1982	1973
◦ UZB	1998	

Continued...

TABLE 1: List of considered countries with FF breaks in Chapter 1 (h=8)

Country Code	Positive	Negative
◦ VCT	1980	2006
◦ VEN	1967	1958
	1985	1977
	2003	1993
◦ VGB	1990	1980
		1998
		2006
◦ VNM	1990	
◦ YEM		2006
◦ ZAF	1998	1970
		1981
◦ ZMB	1989	1963
	1997	2005
◦ ZWE	1960	1968
	1976	1994
	2004	

No true break is identified for Norway using trimming factor 8.

Appendix A.2

TABLE 2: State of Development (region-wise) Quadripartite Decomposition Indices (positive breaks)

Region	Dev. State	GDP Growth	EFFCH	TECH	KACC	HACC
Africa	hd	3.76	3.12	-0.38	0.73	1.22
	md	4.22	2.49	-0.39	2.10	1.24
	ld	4.93	3.84	0.15	0.80	1.22
Asia	vhd	9.80	6.00	2.03	1.44	1.15
	hd	6.12	3.06	0.97	1.89	1.18
	md	6.52	4.86	0.18	1.33	1.18
	ld	2.61	1.32	-0.67	1.91	1.21
Europe	vhd	3.39	1.95	0.36	1.05	1.08
	hd	5.66	2.90	1.57	1.34	1.06
	md	7.94	8.61	0	-0.68	1.05
North &	vhd	2.03	2.17	-0.92	0.69	1.04
Central	hd	3.68	1.31	0.26	2.08	1.10
America	md	2.39	0.08	0.70	1.59	1.17
	ld	2.50	-0.28	-0.55	3.33	1.09
Oceania	vhd	2.24	1.33	-0.08	0.94	1.03
	hd	5.03	3.03	1.17	0.70	1.14
South	vhd	6.66	4.29	1.38	0.88	1.08
America	hd	7.13	3.11	2.52	1.26	1.11
	md	1.12	-0.74	-0.24	2.06	1.14

Appendix A.2

TABLE 3: State of Development (region-wise) Quadripartite Decomposition Indices (negative breaks)

Region	**Dev. State**	**GDP Growth**	**EFFCH**	**TECH**	**KACC**	**HACC**
Africa	hd	-2.47	0.32	-2.44	-0.51	1.30
	md	-3.02	-1.54	0.16	-1.67	1.30
	ld	-4.22	-3.14	-0.10	-0.89	1.24
Asia	vhd	-6.52	-4.75	-1.00	-0.24	1.16
	hd	-4.90	-2.13	-0.72	-1.97	1.22
	md	-6.19	-4.06	-1.78	0.88	1.23
	ld	-3.56	-1.23	-0.19	-1.94	1.20
Europe	vhd	-2.71	0.24	-2.15	-1.01	1.08
	hd	-2.13	-0.81	0.06	-1.46	1.09
North &	vhd	-0.68	3.19	-3.85	-0.29	1.08
Central	hd	-6.30	-3.02	-1.69	-1.44	1.09
America	md	-7.21	-3.68	0.31	-3.71	1.22
	ld	-8.33	-6.50	0.00	-1.55	1.21
Oceania	vhd	-3.52	-4.82	2.36	-0.68	1.06
	hd	-7.27	-6.27	0.00	-0.66	1.14
South	vhd	-4.17	-3.47	0.07	-0.66	1.06
America	hd	-4.06	-2.30	0.06	-1.76	1.17
	md	-5.93	-4.31	1.10	-2.59	1.14

Appendix A.3

Code for the Malmquist Productivity Index.

```
my.data=read.table(file.choose(),header=T)(data.csv)
y=cbind(my.data$rgdpo)
x=cbind(my.data$rkna, my.data$hatlabor)
library(plm)
my.data=plm.data(my.data, index=c("countrycode","year"))
my.data=na.omit(my.data)
my.ctry=c("Country Codes")
my.data=my.data[my.data$countrycode %in% my.ctry,]
my.data=my.data[my.data$year%in% 1950:2014,]
my.data1=my.data[my.data$countrycode%in% my.ctry,]
my.data1=my.data[my.data$year%in% year2:year2,]
my.data2=my.data[my.data$countrycode %in% my.ctry,]
my.data2=my.data[my.data$year%in% year3:year3,]
my.data3=my.data[my.data$countrycode %in% my.ctry,]
my.data3=my.data[my.data$year%in% year1:year1,]
library(FEAR)
X1=cbind(my.data1$rkna,my.data1$hatlabor)
Y1=as.matrix(c(my.data1$rgdpo))
X2=cbind(my.data2$rkna, my.data2$hatlabor)
Y2=as.matrix(c(my.data2$rgdpo))
X3=cbind(my.data3$rkna, my.data3$hatlabor)
Y3=as.matrix(c(my.data3$rgdpo))
```

```
seq.malm = function(X1,Y1,X2,Y2,X1REF=rbind(X1,X3),Y1REF=rbind(Y1,Y3),
X2REF=rbind(X2,X1,X3),Y2REF=rbind(Y2,Y1,Y3),ORIENTATION=2,RTS=3)[
```

D11 = 1/dea(t(X1),t(Y1),RTS=RTS,ORIENTATION=ORIENTATION,XREF=t(X1REF),YREF=t(Y1REF))
D12 = 1/dea(t(X1),t(Y1),RTS=RTS,ORIENTATION=ORIENTATION,XREF=t(X2REF),YREF=t(Y2REF))
D21 = 1/dea(t(X2),t(Y2),RTS=RTS,ORIENTATION=ORIENTATION,XREF=t(X1REF),YREF=t(Y1REF))
D22 = 1/dea(t(X2),t(Y2),RTS=RTS,ORIENTATION=ORIENTATION,XREF=t(X2REF),YREF=t(Y2REF))

if (ORIENTATION==2)effch = D11/D22; techch = sqrt((D22/D21)*(D12/D11));
capdeep=sqrt((D21/D11)*(D22/D12))

print(return(list(effch=effch,techch=techch,capdeep=capdeep, D11=D11,D22=D22,D12=D12,D21=D21)))]

malm=seq.malm(X1,Y1,X2,Y2, X1REF=rbind(X1,X3), Y1REF=rbind(Y1,Y3), X2REF=rbind(X2,X1,X3),
Y2REF=rbind(Y2,Y1,Y3), RTS=3, ORIENTATION=2)

Appendix B.1

Countries Included

Tables 4 and 5 give the list of the 33 advanced economies (as listed by IMF having a Human Development Index (HDI) above 0.8) and 49 developing economies considered in chapter 2 alongwith summary statistics of efficiency estimates.

TABLE 4: List of Selected Advanced Economies

Country	Mean	St. Dev.	Minimum	Maximum
◦ Argentina	1.060	0.023	1.027	1.102
◦ Australia	1.001	0.0001	1.001	1.002
◦ Austria	1.000	0.0001	1.000	1.001
◦ Bahrain	1.021	0.015	1.002	1.056
◦ Belgium	1.003	0.0001	1.003	1.003
◦ Canada	1.003	0.0002	1.003	1.003
◦ Chile	1.065	0.041	1.011	1.140
◦ Cyprus	1.003	0.003	1.001	1.013
◦ Denmark	1.002	0.0001	1.002	1.003
◦ Finland	1.013	0.0008	1.013	1.015
◦ France	1.007	0.0001	1.007	1.007

Continued...

TABLE 4: List of Selected Advanced Economies

Country	Mean	St. Dev.	Minimum	Maximum
◦ Germany	1.005	0.0002	1.005	1.005
◦ Greece	1.026	0.016	1.005	1.053
◦ Hungary	1.018	0.007	1.010	1.031
◦ Ireland	1.076	0.004	1.062	1.079
◦ Israel	1.001	0.0001	1.000	1.001
◦ Italy	1.0003	0.0001	1.003	1.003
◦ Japan	1.002	0.001	1.001	1.007
◦ Korea Rep.	1.031	0.016	1.013	1.054
◦ Kuwait	1.020	0.023	1.004	1.092
◦ Luxembourg	1.020	0.019	1.007	1.087
◦ Netherlands	1.010	0.001	1.009	1.012
◦ New Zealand	1.001	0.0001	1.001	1.001
◦ Norway	1.011	0.002	1.010	1.018
◦ Poland	1.072	0.025	1.024	1.099
◦ Portugal	1.025	0.015	1.003	1.050
◦ Saudi Arabia	1.054	0.031	1.010	1.089
◦ Singapore	1.002	0.001	1.001	1.003
◦ Spain	1.001	0.0004	1.001	1.002
◦ Sweden	1.004	0.0001	1.004	1.004
◦ Switzerland	1.001	0.0005	1.001	1.002
◦ UK	1.004	0.0001	1.004	1.005
◦ US	1.011	0.013	1.003	1.059

TABLE 5: List of Selected Developing Economies

Country	Mean	St. Dev.	Minimum	Maximum
◦ Bangladesh	1.304	0.016	1.279	1.332
◦ Bolivia	1.574	0.117	1.410	1.797
◦ Botswana	1.328	0.044	1.255	1.400
◦ Brazil	1.136	0.022	1.092	1.167
◦ Bulgaria	1.072	0.009	1.054	1.080
◦ Burundi	1.058	0.084	1.006	1.259
◦ Cameroon	1.517	0.075	1.409	1.610
◦ China	1.028	0.045	1.008	1.237
◦ Colombia	1.200	0.029	1.155	1.242
◦ Dominican Rep.	1.209	0.015	1.186	1.231
◦ Ecuador	1.322	0.110	1.165	1.527
◦ Egypt	1.054	0.025	1.017	1.094
◦ El Salvador	1.261	0.035	1.194	1.321
◦ Fiji	1.023	0.016	1.012	1.089
◦ Ghana	2.025	0.121	1.900	2.282
◦ Guatemala	1.177	0.029	1.116	1.212
◦ India	1.157	0.064	1.008	1.253
◦ Indonesia	1.584	0.233	1.320	2.012
◦ Iran	1.057	0.021	1.029	1.091
◦ Jamaica	1.148	0.006	1.139	1.159
◦ Jordan	1.027	0.003	1.020	1.032
◦ Kenya	1.748	0.065	1.626	1.905
◦ Lesotho	1.557	0.130	1.063	1.688
◦ Malawi	1.612	0.250	1.223	2.049
◦ Malaysia	1.074	0.032	1.031	1.130

Continued...

Table 5: List of Selected Developing Economies

Country	Mean	St. Dev.	Minimum	Maximum
◦ Mali	1.397	0.126	1.188	1.657
◦ Mauritania	1.963	0.163	1.716	2.302
◦ Mauritius	1.026	0.011	1.011	1.044
◦ Mexico	1.204	0.071	1.100	1.334
◦ Mongolia	1.842	0.145	1.620	2.018
◦ Morocco	1.143	0.033	1.095	1.190
◦ Mozambique	1.066	0.084	1.010	1.256
◦ Namibia	1.761	0.100	1.615	1.906
◦ Nepal	1.207	0.050	1.031	1.279
◦ Pakistan	1.276	0.043	1.178	1.350
◦ Paraguay	1.379	0.220	1.084	1.824
◦ Peru	1.379	0.103	1.231	1.566
◦ Philippines	1.302	0.070	1.202	1.446
◦ Rwanda	1.128	0.078	1.045	1.275
◦ Senegal	1.206	0.007	1.199	1.226
◦ South Africa	1.365	0.066	1.260	1.452
◦ Sri Lanka	1.219	0.119	1.048	1.436
◦ Swaziland	1.533	0.239	1.293	1.908
◦ Tanzania	2.056	0.096	1.937	2.268
◦ Thailand	1.079	0.029	1.046	1.133
◦ Tunisia	1.085	0.029	1.031	1.130
◦ Turkey	1.073	0.027	1.025	1.106
◦ Uganda	1.404	0.121	1.273	1.659
◦ Uruguay	1.048	0.017	1.022	1.072

Appendix B.2

Bias Corrected Data Envelopment Analysis with Environmental Variables

Package "rDEA"
Authors: Jack Simm and Galina Besstremyannaya

Y=cbind(output variables)
X=cbind(input variables)
Z=cbind(environmental variables)

Bias corrected DEA scores

DEA scores=dea.robust(X=x, Y=y, model="output",RTS="variable", alpha=0.05, bw="cv")

Bias corrected DEA score in variable RTS, output-oriented model with environmental variables.

results=dea.env.robust(X=x,Y=y,Z=z,model="output",RTS="variable",L1=100,L2=2000, alpha=0.05)

Appendix C.1

Table 6: List of 103 Countries considered in Chapter 3

Country List	
◦ Algeria	◦ Jordan
◦ Argentina	◦ Kenya
◦ Australia	◦ Korea, Rep.
◦ Austria	◦ Kuwait
◦ Bangladesh	◦ Lesotho
◦ Barbados	◦ Madagascar
◦ Belgium	◦ Malawi
◦ Belize	◦ Malaysia
◦ Benin	◦ Mali
◦ Bolivia	◦ Malta
◦ Botswana	◦ Mauritania
◦ Brazil	◦ Mauritius
◦ Burkina Faso	◦ Mexico
◦ Burundi	◦ Morocco
◦ Cabo Verde	◦ Nepal
◦ Cameroon	◦ Netherlands

Continued...

TABLE 6: List of 103 Countries considered in Chapter 3

Country List	
◦ Canada	◦ New Zealand
◦ Central African Rep.	◦ Nicaragua
◦ Chad	◦ Niger
◦ Chile	◦ Nigeria
◦ China	◦ Norway
◦ Colombia	◦ Oman
◦ Congo, Dem. Rep.	◦ Pakistan
◦ Congo, Rep. of	◦ Panama
◦ Costa Rica	◦ Paraguay
◦ Cote d'Ivoire	◦ Peru
◦ Cyprus	◦ Philippines
◦ Denmark	◦ Portugal
◦ Dominican Rep.	◦ Rwanda
◦ Ecuador	◦ Saudi Arabia
◦ Egypt	◦ Senegal
◦ El Salvador	◦ Sierra Leone
◦ Fiji	◦ Spain
◦ Finland	◦ Sri Lanks
◦ France	◦ St. Lucia
◦ Gabon	◦ St. Vincent and
◦ Gambia, The	◦ Sudan
◦ Germany	◦ Suriname
◦ Ghana	◦ Swaziland
◦ Greece	◦ Sweden

Continued...

TABLE 6: List of 103 Countries considered in Chapter 3

Country List	
◦ Guatemala	◦ Switzerland
◦ Honduras	◦ Thailand
◦ Iceland	◦ Togo
◦ India	◦ Trinidad and To
◦ Indonesia	◦ Tunisia
◦ Iran	◦ Turkey
◦ Ireland	◦ Uganda
◦ Israel	◦ UK
◦ Italy	◦ United States
◦ Jamaica	◦ Uruguay
◦ Japan	◦ Venezuela, RB
	◦ Zimbabwe

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Affidavit

I hereby declare that I have written the present dissertation by my own and have not used other than the acknowledged resources and aids. Furthermore, I confirm that the dissertation has neither been accepted nor graded failed in a previous doctoral procedure.

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